tech engineering news

october - november 19

static and the planets

Another page for **YOUR BEARING NOTEBOOK**

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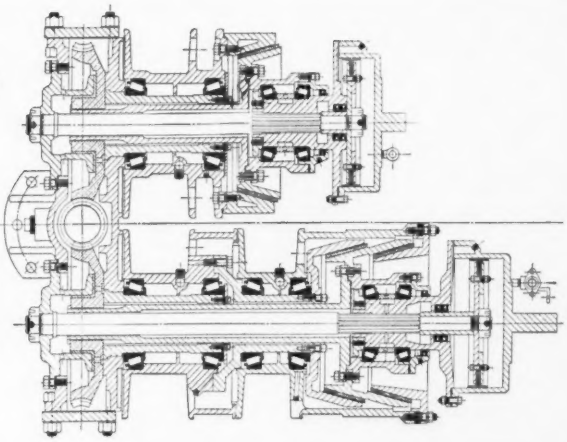

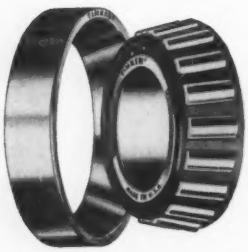

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Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

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THE DU PONT DIGEST

M.E.'s AT DU PONT

Diversity of chemical products spells opportunity for the mechanical engineer

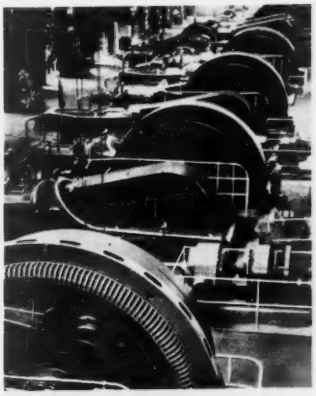
Students of mechanical engineering sometimes assume there is little opportunity for them in the chemical industry. In fields where products are made in more or less standardized equipment, this may be so.

But in a company like Du Pont which operates in many fields of industrial chemistry—where products are made at pressures over 15,000 pounds per square inch as well as in vacua low as two millimeters of mercury—mechanical engineers are in heavy demand.

What jobs do they fill at Du Pont? Literally hundreds, not including the normal run of mechanical engineering work such as design of standard equipment, scaling up from blueprints, etc.

For example, here are some of the problems encountered in the manufacture of nylon yarn alone:

1. Nylon polymer, a poor thermal conductor, is melted by a contact surface grid at 550°F. The polymer decomposes slowly at this temperature, and there is a major heat-transfer problem. Many types of melting grids had to be designed before one proved satisfactory.



The compression *stages of these 50 ton/day hypercompressors (15,000 p.s.i.) for nitrogen, hydrogen, etc., were designed by Du Pont mechanical engineers.*

2. The molten polymer is pumped to spinnerets under pressures over 1000 pounds per square inch. With nylon as the only lubricant, the pumps must operate continuously at 550°F. Specialized problems in sealing, gasketing and materials of construction are inherent in this operation.

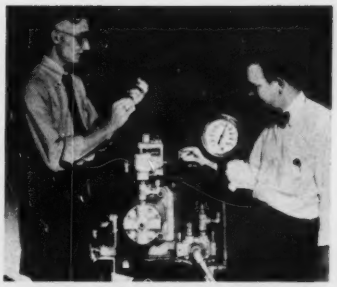
3. The melt is forced through multiple holes (diameters of 7 to 22 thousandths of an inch) in a special alloy disc. They must be made to conform to "jeweler's specifications."

4. The emerging fibers are cooled in a specially designed "air conditioned" chimney. Precise control is essential in this critical operation.

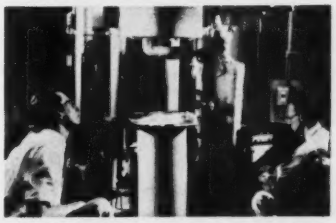
5. The fibers are wound on spools at surface speeds around 1000 yards per minute. Design calls for constant change in speed so that there is no localized stretching or relaxation of the fiber.

6. Finally, the fiber is drawn about 400% and wound on spools traveling at 5000 feet per minute. Bearing lubrication and dynamic balance presented important design problems.

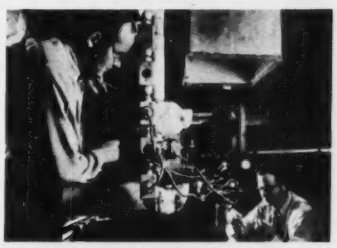
These are but a small part of the mechanical engineering problems arising in the manufacture of a single product by only one of Du Pont's ten manufacturing departments. Literally hundreds of other products, ranging all the way from cellulose sponges to metals like titanium, present similar challenges. So long as new processes continue to be sought and old processes improved, there will be important work for the hand and mind of the mechanical engineer.



Ralph C. Grubb, *B.S.M.E., Tennessee '51, and Paul D. Kohl, B.S.M.E., Purdue '46, study characteristics of a super-pressure pump (75,000 p.s.i.) designed by Du Pont engineers and made in Du Pont shops.*



Heat-transfer *problems in the design of new fiber-spinning equipment are investigated by J. C. Whitmore, B.S.M.E., Virginia '44, M.S.M.E., Delaware '49, and L.B. Collat, B.S.M.E., Georgia Tech '50.*



Uniquely designed *adapter for a screw extruder under study by Ralph J. Covell, B.S. M.E., Purdue '49, and John F. Bowling, B.S.M.E., Purdue '41. The adapter heats, filters and forms polymer into filaments.*

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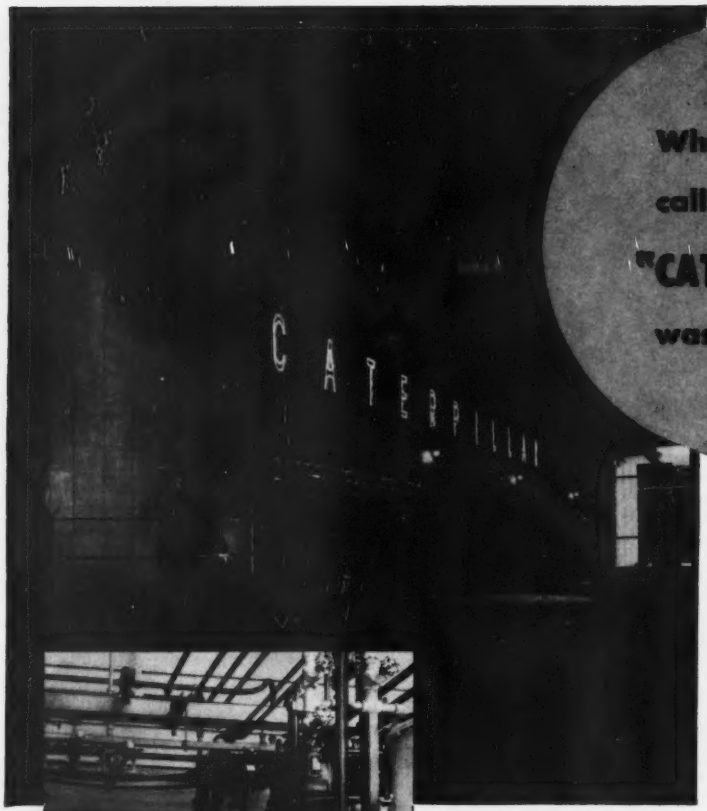
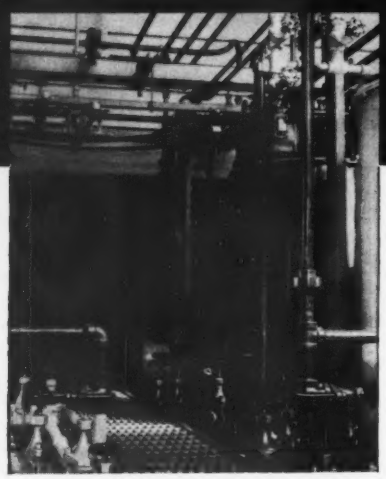


Another of America's vital plants equipped for lasting efficiency with

JENKINS VALVES



Among the thousands of Jenkins Valves on plant pipelines are these, where the identifying "highway yellow" paint for "Caterpillar" machines is prepared. Over 300 valves are used for flow control in each of several paint mixing units.

They're working around the clock these days at Caterpillar Tractor Co., Peoria, Ill. — one of the largest producers of earth-moving equipment and diesel engines. The big yellow "Caterpillar" machines are urgently needed—both for Defense and for essential civilian construction.

Future-minded planning of this modern industrial plant helps keep production moving. All operating equipment, for example, was selected on the basis of performance and long service life. The engine factory (above), like every building of Caterpillar Tractor Co., is equipped with Jenkins Valves.

Today, Jenkins is bending every effort to meet the Nation's need for valves. It's a big order. The men responsible for the defense production program know that valves are vital to plants readying the country for any emergency. And leading architects, engineers, and contractors rely on Jenkins for peak operating efficiency and economy.

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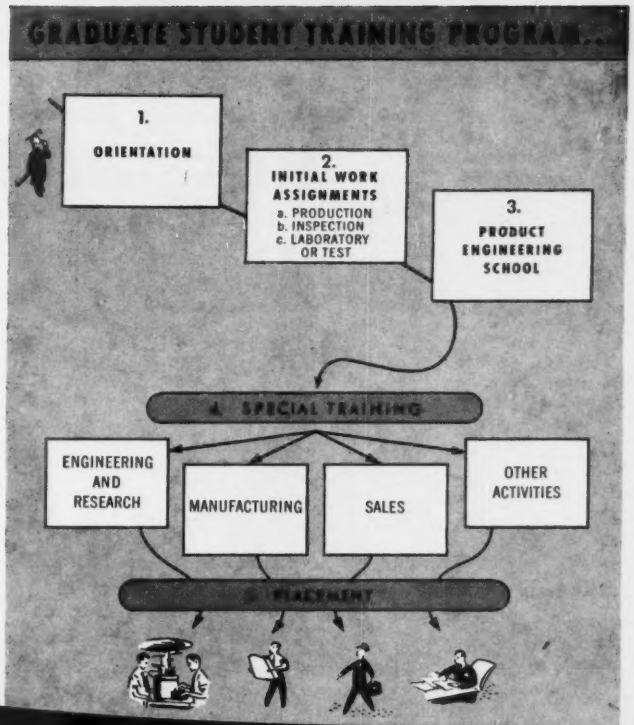

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tech engineering news

October 1951
Vol. XXXIII No. 1

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Published monthly during the school year at Walker Memorial, Cambridge 39, Massachusetts, by the undergraduates of the Massachusetts Institute of Technology. Entered as second class matter, at the Post Office, June 1, 1920, at Boston, Massachusetts under the Act of March 3, 1879. Copyright 1951 by The Tech Engineering News. Subscription per year $1.75. Foreign $2.50. One copy 25 cents.

the cost of an education

How Much You Will Spend This Year

By Charles M. Saltsman, '52

We are again at the start of a year of sweat and study at Tech. For the upperclassmen, this will be an old story, with variations, of course. But for freshmen it will be a new experience. Like many thousands before them, they will slowly find their way about, learning the peculiarities of MIT, and, one by one, will fall into the pattern of life they'll follow the next four years.

In the next four years, depending on the course you decide to follow, you will sit down at desks, tables, and drawing boards, and solve, or try to solve, from two to three thousand problems. Within a very short time, you will be worrying about force vectors and resultants, integrals and series, pressures and volumes. But before you decided to tackle all this, most of you, along with a few people back home, had another problem. Almost as soon as you decided to come to Tech, perhaps long before, you wondered how much it was going to cost. You compared the costs of other schools with that of MIT. You doubtlessly spent some time considering tuition, books, fees, room, board, expenses, and travel estimates. It was a pretty sizable sum. In the following paragraphs and diagrams, you will find a comparison of the price of a Tech education with that of thirty-three other colleges and universities. These are all men's or co-educational institutions; schools you might have attended. Most of them are well known, but a few of the lesser known ones are also listed. In the final analysis, a dozen girls' colleges are included for comparison. Incidentally, there are no figures assigned to the comparison charts. In these times, any listing of precise values becomes outdated almost immediately, while a qualitative comparison remains substantially constant. Included in the discussion, you will find figures, facts, estimates, averages, and hints pertaining to the Tech student and his dollar. Finally, there follows a short part concerned with another important quantity you will be spending here at Tech. This quantity is time: the facts are taken from the *Tech Engineering News*' student poll of 1950.

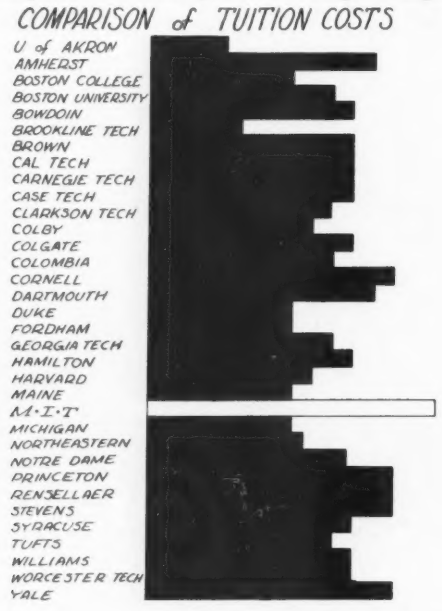


Figure 1

Comparison of College Costs

It isn't difficult to see from Figure 1 that of the thirty-four male and co-educational institutions selected, MIT leads the field as far as tuition is concerned. In fact, tuition at Tech exceeds that of any of the other schools by at least $100. On this basis, many have stated that Tech is the most expensive college in the country. This statement, while not far from true, requires qualification. Excluding girls' colleges and the most exceptional cases (i.e. schools specializing in student guidance, physical and psychological problems, etc.), Tech has the highest tuition. To arrive at Figure 2, a fixed amount for additional fees has been added to the tuition of each school, and an average amount (based on that college's estimate) for room and board. On this basis, both Yale and Princeton are seen to cost more than Tech, even though the difference is not large. With the exceptions of Syracuse and Tufts, all the other

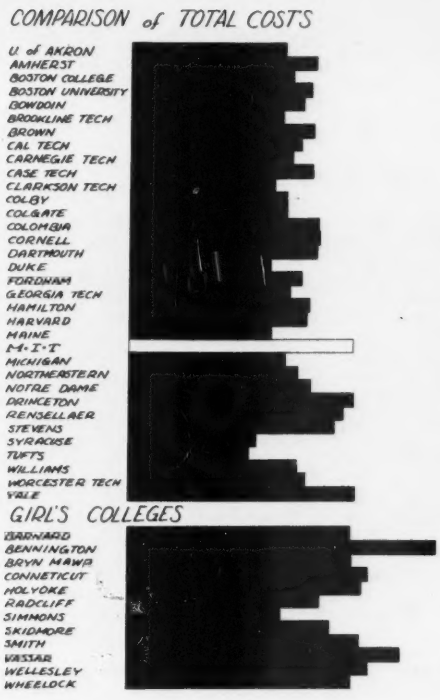


Figure 2

colleges have caught up with Tech to some extent. The price of education here is still above the average, but the gap has been closed considerably.

A major factor in the difference between Figures 1 and 2 on a comparative basis is the matter of fees that must be paid and that are not included in the tuition. These may consist of health insurance, breakage and lab deposits, athletic and social dues, and activities and materials fees. One college, an extreme, and not included on the charts, has no less than twelve separate fees totalling $114. All of these must be paid to different organizations at different times, rather than in one sum, as Tech requires. Other schools vary widely from the two extremes, and in any one of them, the fees may vary from course to course.

The other factor, room and board, varies with the school and with the school's location. Although some upperclassmen may wish to take issue with this, Tech compares rather favorably with the others, being only slightly above the average.

Also included in Figure 2 is a chart showing the cost of tuition, room, board, and fees of twelve girls' colleges. One thing seems evident from a comparison of the two groups: it costs more to educate a girl than it does a boy. This conclusion may be somewhat misleading, for while the cost of attending Vassar, Wellesley, or Smith is higher than any of the male or co-ed colleges, the former generally provide a greater amount of social activity for the students. Boys are expected, to a large extent, to provide their own recreation at their own expense; girls, on the other hand, either have dates, which cost them relatively little, or they remain within the school campus where some sort of entertainment is provided for them.

Yes, an MIT education costs a great deal when compared with other schools. But let us not forget that for the price, we are getting a pretty good bargain in education.

The Cost of Tech

Tech's tuition is $800, health insurance $18, and, at least for freshmen, lab deposit $25. Unless you have a scholarship, you cannot attend Tech for less than $843. You will pay this in two lump sums, $434 at the beginning of the first term, and $409 at the beginning of the second. While this is a lot of money for most students, there is a certain beauty in having the rate the same for every course, the same for every student, and payable in two fixed sums. There are very few schools that can explain their tuition and fees in so few words.

Having reached and passed the day of reckoning with the Bursar's office, you must start thinking about a room and some food. Here you will doubtlessly take your place in one of five groups: (1) dormitory, (2) fraternity, (3) commuter, (4) boarder, (5) married.

Members of the last group are rare among the freshman class and because of this, and the difficulty in obtaining any sort of accuracy in such cases, these have been omitted. If you live close enough to commute, and your finances are somewhat shaky, you can certainly do no better by living on or nearer the campus.

To the $843 you need only to add your transportation. Boarding is the best plan if it is impossible for you to commute, and yet you must live with the greatest economy. No attempt was made to estimate how much this would cost, as cases vary tremendously. By renting a room nearby and doing some or all of your own cooking, you may make a sizable saving.

The students who live on campus are perhaps the most significant group. These men have the choice of living in a dormitory or in a fraternity. The question of joining a fraternity is an important problem for many students. Only the financial aspects of the two are presented here. They are based on a survey of eighteen fraternities, Baker House, East Campus Dorms, and Riverside, made in March, 1951. The results show the cost of room and meals each month to be:

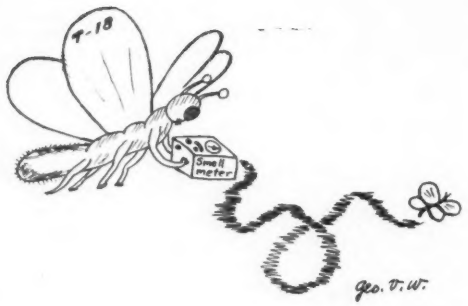
(*Continued on page 18*)

the sense of smell

Quantitative Studies of Odors

By Bert Krauss, '54

Our only contact with the outside world is through our senses. While all of these are rather unreliable, the least dependable is our sense of smell, for as yet no one has been able to distinctly classify the different odors in a manner analogous to the classification of light, sound, or taste. It is also frequently a misleading sense because we tend to associate bad or unfamiliar smells with danger. However, this instinctive feeling



of danger is useful to us in a manner I shall describe later.

Logically the first thing to consider is how we smell (by this we mean the mechanics of smelling). It would be erroneous to think that one smells only through one's nose, for the sense of smell can be reached through the mouth as well. The popular belief is that odors are caused by substances in the gaseous state which are inhaled and make contact with the mucus of the olfactory area. This is an area of approximately 1,250 square millimeters in the upper reaches of the nose. The sensation is transmitted from tiny hairs to the nerves and finally to the olfactory bulb of the brain. Just how the hairs receive and transmit the surface contact is not yet fully understood.

A revolutionary new theory has been developed by Doctors Miles and Beck of Yale University. They hold that the nose broadcasts infrared rays of varying wave lengths. These rays are absorbed by gases given off by the object being smelled. The resulting loss of heat and increase in radiation is transmitted to the brain which interprets the smell. Different odors are recognized because each gas absorbs a different wave length of infrared rays.

In an experiment with bees, honey was placed in two identical sealed iron boxes. One box had a window which allowed infrared rays to pass through while the other did not. It was found that the bees clustered about the box with the infrared transparent window in a ratio of ten to one.

Another new theory has been developed by Doctor Kistiakowsky of Harvard. He believes odors are caused by enzymes, which have the ability to produce the transformation of chemical compounds. Smells are obtained through a change in the concentration of the enzymes. The intensity and its lingering effect is dependent on the extent enzymes are blocked in their action and the reversibility of the change caused.

A great deal of work has been done on odor classification; however, no really satisfactory system has been found. Each of the methods divides odors into different categories but basically each relies on the human element and on our familiarity with certain smells.

Zwaardemaker's classification was based on familiar odors. Thus his system ran something like this:

Aromatic: camphoraceous — borneol, camphor
spicy — ginger, pepper, eugrol
Fragrant: floral — jasmine, lilac, orange blossom
lily — violet, narcissus, tuberose

Earps method uses physiological action. For example, wintergreen and violet increase the flow of blood to the brain. Other odors cause nausea, increase saliva flow and so on.

The Crocker Henderson method is perhaps the most quantitative. All odors are divided into four basic categories: (1) fragrant or sweet; (2) acid or sour; (3) burnt; (4) capryllic or goaty. Odors are then graded by the use of four digits, each of which stands for one of the four classifications. Each of the classifications is graded from zero to eight according to its intensity in the odor. Thus vanillin is 7122, meaning

(*Continued on page 20*)

a magic tesseract

Or "How to Waste Time in Four Dimensions"

By James Stuart, '51

Left to chance, the discovery of a magic tesseract would have been improbable. Were development of a use for it a prerequisite for its discovery, the discovery of a magic tesseract would have been impossible.

A "magic square" array of numbers is simply one in which each row and column has the same total. Odds against getting one made up of nine consecutive numbers placed at random in a tic-tac-toe square are 2,016 to 1. For a 3 by 3 by 3 magic cube, chances are less than 1 in 10^{23}, and for a 3 by 3 by 3 by 3 magic tesseract, they are about one in a googol which is 10^{100} or one followed by more zeros than I have time or energy to write.

Historical predecessor and useful relative of the magic square is the Latin Square. An n by n Latin Square is formed of n classes containing n items each, arranged in a square array such that no row or column contains two items of the same class.

I	II	III
II	III	I
III	I	II

A III by III Latin Square

The Latin Square is used by statisticians in designing experiments — it is the black sheep of the otherwise useless magic family.

Now suppose that there are n different types of items, one of each in each of the n classes. If you get them arranged so that there is only one item of each type per row and per column, you have a Graeco-Latin or (excuse the word) Euler Square. For example, let the classes — a,b,c — be families of triplets, and the types — A,B,C — be the order born.

Aa	*Bc*	*Cb*
Bb	*Ca*	*Ac*
Cc	*Ab*	*Ba*

Euler Square

It can be seen that the Euler Square consists of a combination of two Latin Squares.

It is obvious (i.e. too much work to explain why) that an n by n magic square can be derived from every n by n Euler Square by numbering the classes and the types from 0 to $(n-1)$, multiplying the type number by n, and considering the whole as a single number. This can be done most easily by using the base n rather than the base 10. With both the small and capital "a" represented by 0, the "b's" by 1, and the "c's" by 2, our Euler Square becomes:

00	12	21
11	20	02
22	01	10

Magic Square to base 3

0	5	7
4	6	2
8	1	3

Same to base 10

The mathematical geniuses amongst you can easily see that the columns and rows each add up to 12 (110 to base 3).

Being a rather rugged creature, the magic square is not destroyed, but only converted to another magic square by interchanging any two rows or any two columns, or by rotating it about its center or one of its diameters. Thus in the case of the 3 by 3 magic square, there is really only one solution. This property, the non-numerical character of the Euler Square, and the general "looks" of the squares indicate that order, relative (rather than absolute) position and not numerical value are basic to the magic square which is based on the Euler Square.

Many years ago in my carefree youth I spent about a hundred hours trying to devise a 3 by 3 by 3 magic cube by a combination of brute force and logical systemization, working with numbers to the base 10. All I managed to do was kill that hundred hours.

Thinking in the number system to the base 3, however, the problem becomes almost trivial, and the solution practically obvious (this saves a lot of explanations). In order to eliminate some of the simplicity I will introduce a system of abbreviation and notation

Let $A = \begin{matrix} a \\ b \\ c \end{matrix}$, $pA = B = \begin{matrix} b \\ c \\ a \end{matrix}$, and $p^2A = C = \begin{matrix} c \\ a \\ b \end{matrix}$. Then,

if $a = 0$, $b = 1$, and $c = 2$, the Latin Square may be represented as $A\ \ B\ \ C$, and the Euler Square as $AA\ \ BC\ \ CB$ or $AA\ \ p(AB)\ \ p^2(AC)$.

If we consider the columns A, B, and C as running perpendicular to the page rather than from top to bottom, A looks like 0 from the top; B, 1; and C, 2. Thus if we make a magic square and then substitute A for 0, etc., and add one more place in the proper manner, we will have a magic cube:

(AAA)	$p(AAB)$	$p^2(AAC)$	000	14	*ccb*
$p(ABA)$	$p^2(ABB)$	(ABC)	121	18	*abc*
$p^2(ACA)$	(ACB)	$p(ACC)$	212	7	*baa*

A 3 by 3 Magic Cube — Base 3 — Base 10 — Letters

Its top layer

Noting that the magic cube consists of the "numbers" from AAA to ACC placed in order in a square, operated on by a superimposed Latin Square composed of p to the 0,1, and 2 powers, we see a method of applying the technique to more dimensions.

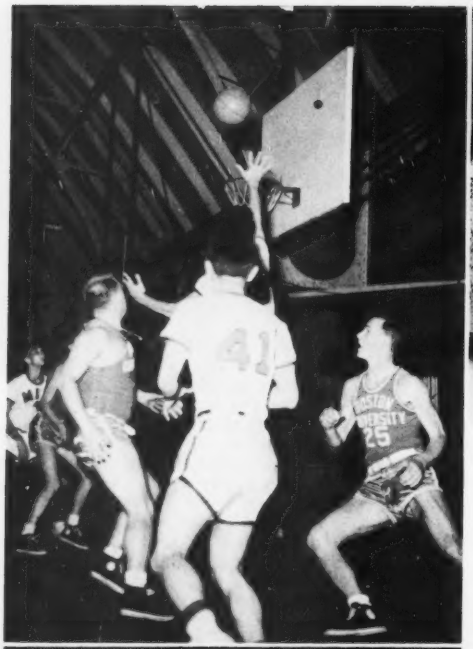
To insure that only an elite few have the vaguest notion what this is all about I will introduce four new abbreviations — considering the $(a\ b\ c)$ of A as extending perpendicular to the page, let U stand for $(A\ B\ C)$, V for pU, X for p^2U and Y for $(A\ C\ B)$, extending down the page. This will have to be in the fourth dimension, since there will be something else extending down the page physically. (If this doesn't stop you nothing will.) With this notation, a magic tesseract may be represented as:

$(YUUU)$	$p(YUUV)$	$p^2(YUUX)$
$p(YUVU)$	$p^2(YUVV)$	$(YUVX)$
$p^2(YUXU)$	$(YUXV)$	$p(YUXX)$

The Y is necessary, since $UUUU$ would give $AAAA$, $BBBB$, and $CCCC$, each of which would give 0000, 1111 and 2222, thus causing a duplication of numbers.

Inscribed on the five dimensional equivalent of the torus, it can be shown that there is only one basic 3 by 3 by 3 by 3 magic tesseract; thus the following is

(*Continued on page 40*)



One of the big events at Tech is the annual Tech's-a-Poppin' round of sports events and dance. Here we see the Tech cagers and skaters in action.

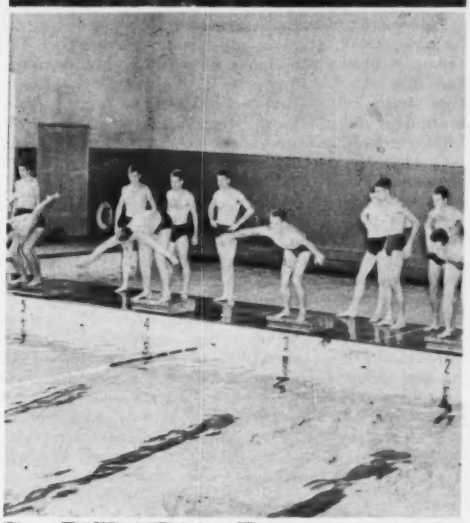
fun at tech

"Tech is hell." We've all said it, and we must admit that (especially before quizzes) there is a great deal of truth to this statement. But there's a brighter side to the picture, which is what we have tried to illustrate on this page.

The fresh humor and songs of Tech Show certainly provide one break in the monotony of school life. The Freshman Dance and the class dances after that can be memorable occasions. Who will forget the glove fight on Field Day? Then, there's the quiet pleasure of a sail on the Charles River, or an hour spent in the music library. And, of course, we can't ignore that most common source of pleasure at Tech: Just loafing. This surely is time well spent!

Campus dramatic talent is displayed in Tech Show. The Egyptian locale of last year's *Call Me Mummy* is evident.

Frosh-soph rivalry culminates in Field Day. At two extremes of violence are the Field Day Dance (above) and the Glove Fight (right), where each class tries to remove the other's pants and/or gloves. Below right opposing tankers are poised for action.



The Field Day rivalry extends to all sports. Directly above, one of the crews races under the Harvard Bridge. At bottom left, the soph ball carrier seems to be headed for a spill. At bottom right the tug-o'-war boys do their stuff.

ostheimer's rule

By Rudolph W. Preisendorfer, '52

(a) If initial and terminus ports are relatively contra-terrene, then an *odd* number of disjoint power intervals in transit are required before terminus contact. Minimum power intervals required: ONE.

(b) If initial and terminus ports are relatively terrene, then an *even* number of disjoint power intervals in transit are required before terminus contact. Minimum power intervals required: TWO (cf. DEFINITIONS, pp. 114–118).

J. Anoreaux, "Bulletin 72, Bureau of Operations and Navigation" (New Washington, 2012), p. 110.

Herrmann Ostheimer pressed the tobacco firmly into his pipe, struck a match, and carefully lit the pipe. The aromatic blue-white smoke blew about him and was torn into invisible fragments in the brisk Pacific breeze that swept, full of the smell of salt and sea, over and around his small cottage. The cottage stood on a green bluff overlooking the wide expanse of the Pacific. Here he rested quietly, living out his last, contented, years in complete peace and quiet. He reclined comfortably on a wicker chair, feet propped on the white railing of the little patio that faced the sea, silver hair slightly ruffled from fresh morning breeze. The silver hair contrasted highly with deeply tanned hands and face, a tan that came from years of mild exposure to the shielded actinic light of many suns other than good old Sol. It had been many years since the light of an alien sun had shone brightly through a helmet visor onto his face, or through the observation ports of one of the many vessels he had shipped on, but the deep tan would remain, bleaching only slightly as the years wore on. He would never see those suns again, except as brightly winking sparks in the dark evening sky. The years had passed by, and with them they carried his youth. And with them they took Martha, his wife. And his children and their children were now far away, among the stars somewhere. Where? Oh, let's see, Karl and his brood would be out in the Centauri system; Margarot and Elfrieda would be nicely settled in the Rigel colonies, and Christian would be spending the last few years of his last hitch with the colonization teams, getting the farthermost outpost into shape for a new swarm of eager, land-hungry Earthlings to settle on. That would be on the Wedrochebenken system, let's see, yes, about a hundred and eighty-four light years out, past the Southern Cross.

He puffed abstractedly on his old briar. The far-off sounds of yesteryear were a half-forgotten melody playing in the back of his mind. Bright sunny days of many years ago. Rainy days. Happy days. Sad days. Autumns and springs. Bright red leaves, falling; bright green leaves, growing. Strange horizons, triple-mooned skies, orange seas, yellow skies, wine-colored clouds. The ships, the crews, the voyages, quick and all too short. The Nikkersson drive did all that. But it almost didn't. The key that opened the heavens to the peoples of Earth, nearly locked them off

again with equal abruptness. The Nikkersson drive. The key, and almost the closing curtain. Almost.

The images in Ostheimer's scanning memory sharpened. They focused on a bright sunlit scene. A desert scene. Men and equipment. The smell of gasoline, and rubber, of bright new factory paint, of the sweat of men. The sound of the wind on the sands, the whining of pumps and laboring trucks sinking deeply in the golden sands, carrying their burdens. A tall tower of shining aluminum, bedecked with cables; and hoses, sucking up into its dark interior the bitter cold food

for its sustenance during its long dark journey between the Earth and its moon. The hot August sun beat down upon men and machines; a hot, August sun of fifty-three short, all too short, years ago.

On a cloudless August morning of 1998, the golden sands of Oraibi, Arizona brightened to incandescent whiteness under the jets of the *Wac Major-IX*. She rose with majestic slowness into the bright blue sky, leaving only a ragged white plume in the upper atmosphere, and a tumbling step rocket falling minutes later somewhere in the desert sands. Thirty-two and a half hours later, the Blagovyeshchensk Observatory wired the Harvard clearing station: "Radiation flare from the *WAC Major-IX* observed on the northern plains of the Mare Serenitatis, 1013.3 hours GST."

And that was that. The beginning, that is.

A smile crept across the tanned face of Herrmann Ostheimer as he recalled the jubilance with which he and his fellow workers had received the heartening news. That was the beginning, he recalled. Then, after that, in quick succession, came the *Wac Colonels*, the *WAc Generals*, each larger, sleeker, faster than its predecessor. Each was an engineering triumph that shaded the forerunners into insignificance. Their fingers, hands, and faces burned to a deep brown under the hot Arizona sun, but their hearts were full with ever new expectancy. Disappointments were few, and success tumbled upon success. The days flashed by, leaving a fiery streak of accomplishment. The pinnacle of achievement was being approached. The memories for old Ostheimer were poignant, but their sharpness was filled with a nostalgic longing. He fondled the cold pipe (it had long gone out), and looked abstractedly out over the blue expanse before him. The sun was higher in the sky, and the winds were warmer, and softer. Yes, he thought, that was the beginning.

His eyes closed slightly, in recall. There again were the brilliant golden-white sands, the machines, the men, the sounds. The life of half a century ago was all about him in his mind's eye and ear. There stood the final product upon the shimmering sands. The tall, silver spindle which would cradle in its spider-work steel insides a living human being. When it left the burning sands below it, it would have a human passenger, and would bear him out into the vacuum between two worlds. It was June 2002, one of the hottest Junes that had ever scorched the Oraibi sands. The sweat poured from the bare backs of the men who tenderly nursed the energy-giving chemicals into the rocket's hungry bosom. The oxygen hoses gave off clouds of frosty white mists. Everything was either all heat or all cold. Emotions were all hope. That was the day of days. A day that packed a double-barrelled punch that is still ringing.

For, on the day that the *Wac Commander* bore its living burden up into the frosty, black depths of space, on the day that the first man-bearing chemical rocket successfully carried its cargo of humanity and recording instruments up and out of the domain of the earth's effective gravitational field, the Nikkersson drive was announced. The Nikkersson drive. Its heralding came as a thundering surprise to Ostheimer and his fellow workers. For them it was a mind-staggering reorientation; all of this in one flash of speechless silence, fraught with old dreams being caught up and accelerated in the

breath-taking expanse of the possibilities of the Nikkersson drive.

The chemical rocket had, in one instant, been borne into ultimate reality and plunged into a second-rate achievement. On the strength of an announcement requiring but a few ergs of energy to voice, the years of back-breaking, mind-tearing toil, the tons of energy, of sweat, of steel, and hopes had been dissolved, and in its stead stood a dream that none had dared to dream. A few scratches of blue-black ink in Nikkersson's notebook, some carefully wired benchfuls of electronic gear, the flick of a switch, the drain of a trifling few million ergs of energy, and a copper cube occupied a new position ten feet away in the laboratory after an immeasurably short instant of time.

Ostheimer settled more deeply into the wicker chair, clapped the cold nub of tobacco out on his palm, and let the ashes fall to the patio floor. He placed the stem to his lips and absently cleared the bowl. He could

(*Continued on page 24*)

the psychological diagnostic service

The Newest Addition to M. I. T.'s Counselling Service

By John V. Gilmore, Ed.D., and Dana L. Farnsworth, M.D.

Going away to college is one of life's major experiences, combining as it does the attainment of a high degree of freedom with quite heavy demands on intellectual ability and organization. It is not surprising that many students need help in this new adjustment. Student counselling assumes many forms and is done in some measure by all persons connected with an educational institution, from janitor to president. Such counselling is immensely valuable, but there are numerous instances of complicated situations that are too difficult for the amateur, and a specialist must be consulted.

The newest of the specialized services available to MIT students is the Psychological Diagnostic Service which has been added to the office of the Dean of Students. This service had its origin in 1949 when a part-time psychologist was added to the Dean's Office staff. It was followed in 1950 by the addition of a full-time psychometrist. Because of insufficient office space in the Dean's Office for this service, the headquarters have been located in the Medical Department. This has been a fortunate arrangement in many ways for both the Dean's Office and the physicians of the Medical Department, since both groups have great need of psychological consultations from time to time.

Student being timed on block arrangement in manual dexterity test.

Because considerable time is involved in administering tests and in evaluating results, this service has not been used by a large number of students. It is available to all students, but it has attempted specifically to meet the needs of those who are faced with difficult problems such as choice of course, school, or vocation, or those which involve the efficiency and effectiveness of the student, such as poor study habits and poor reading skill.

The services are of special interest to those students who are not sure whether they are best fitted for the work in science or engineering or for a concentration in the humanities and social sciences. They are also helpful to the man who feels that he is not studying effectively and yet does not know the reasons. The student who is unable to make up his mind as to which course he should pursue profitably at MIT might possibly find the psychological services helpful. In other situations the information derived from testing procedures may give a clue as to whether or not an apparently minor emotional problem is really of little significance or whether it is a portent of something more serious.

One of the most valuable contributions of the Psychological Service to both the administration and the student is that it rounds out the investigative methods that are available in searching for the reasons why a student is not doing well. The student who is failing is a common problem to the Dean's Office and to nearly every faculty member at MIT. In a typical instance a student may not be doing as well as his general ability should enable him to do. The cause may be quite obscure to him. After consultation in the Dean's Office, the reason is sometimes readily apparent. In many other instances the services of a specialist such as a minister, another faculty member, a registration officer, a physician, a psychiatrist or a psychologist are greatly needed in the solution of the problem. The basic concept of student counselling at MIT assumes that the individual should be guided as quickly as possible to the person who would be most capable of aiding him. Counselling does not imply that the staff member engages primarily in advising the student what he should or should not do. Instead, the counselor is one who helps him recognize and understand his problem in order that he himself may solve it in the best manner possible. The student is often able to solve his problem if he has additional information about himself.

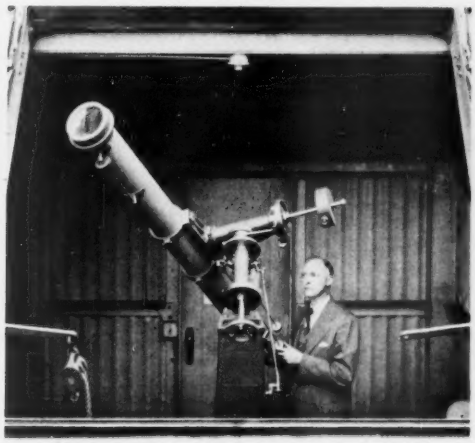
The various instruments and techniques that are used by the Psychological Service for measuring abilities and skills and in diagnosing various kinds of emotional reactions are known collectively as "Psychological Tests." The term psychological test goes beyond the term "aptitude test," which has been used for so many years by both laymen and psychologists. The term "aptitude" is a carry-over from the early days in which tests were built around some particular function such as ability to work with one's hands or ability to be successful in some special field such as music, art, or engineering. The term aptitude, as popularly defined, means a readiness in learning, and the psychologists in the early days of testing used the term to connote the ability to profit from training in some particular area. This places a limit on the usefulness of psychological tests and limits the area of testing to two general regions — namely, general ability and specific ability. In the developmental period of testing, the term aptitude test had an unfortunate connotation because it implied that if a person had a special skill in art or music or science, the genesis and development of this ability came not as

(*Continued on page 28*)

static and the planets

Planet Positions Related to Magnetic Storms

New evidence has been brought into the case of radio communication versus sunspots. In fact, it is possible that there has been more than one culprit responsible for the magnetic storms which periodically sweep the world. According to John H. Nelson of RCA a direct relationship exists between magnetic storms and the position of planets with respect to each other. Mr. Nelson's conclusions were reached after nearly five years of research. Using a six-inch telescope, he daily plotted the position and characteristics of sunspots on the solar surface. He soon became convinced that other factors exerted an influence upon conditions on the Earth.



From this observatory in the heart of New York's financial district, Mr. Nelson has applied his new approach in predicting radio weather months and years ahead.

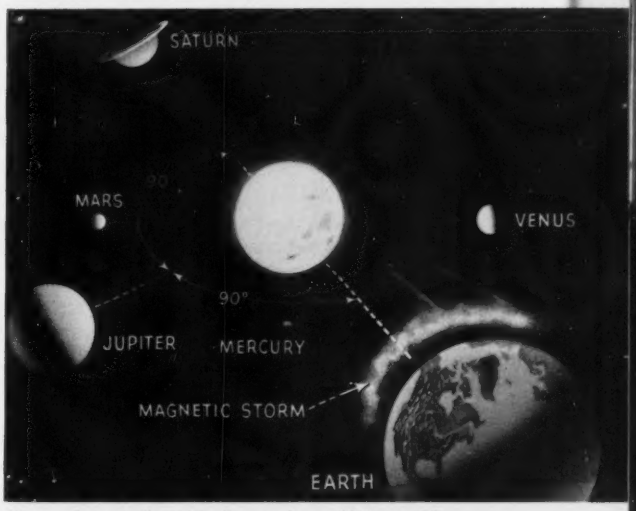
Observation of the course of the six inner planets indicated that when two or more planets are at right angles to each other, or in line with each other, magnetic disturbances occur on the Earth's surface. The most disturbed periods will be those preceding and following the positioning of Saturn and Jupiter in such a configuration with relation to the sun. It seems that the most severe disturbances occur when Mars, Venus, Mercury and the Earth are in a critical relationship near points of the Saturn-Jupiter configuration. On the other hand, the least disturbed periods occur when Saturn, Jupiter and Mars are equally spaced by 120 degrees.

Although the research was concerned with the Earth's magnetic storms in relation to radio communications rather than sunspots, the study indicates that the planets influence the surface of the sun and the solar reactions frequently associated with sunspots.

In developing evidence of planetary influence, hundreds of charts of planet positions, radiotelegraph circuit behavior and sunspots, were prepared, and the relationships between the different charts analyzed. It was found that because of their slow motion around the sun, Saturn and Jupiter may stay in a critical relation to each other for as much as two years. In this event the inner planets, as they circle the sun more rapidly, have an opportunity to create additional critical relationships, which add to the effects of the Saturn-Jupiter team.

Prior investigations showed the size of sunspots to be a meaningless criterion in predicting disruption caused to radio circuits. The type of the sunspots, their age and activity, together with their position on the face of the sun, were declared to be the determining factors of disruptive bombardment. The existence of a "critical zone" on the face of the sun, in an area about 26 degrees in radius from the optical center on its eastern hemisphere, was established at that time. It was discovered that the position of the sunspots in relation to this critical zone was of utmost importance. Damaging effects were noted when new active spots were within this zone. Subsequent investigations have shown this critical zone to be expanding as the sunspot cycle approaches its next low point of activity, which is expected to occur at approximately the end of 1954. This zone remains a valuable asset in making daily forecasts of magnetic weather.

By means of his planetary research, Mr. Nelson has been able to predict for two years in advance the approach of major magnetic disturbances on the Earth's surface. Combining his planetary observations with a daily telescopic inspection of the sun's surface, he has obtained an accuracy of 85 per cent in his daily forecasts of good and bad radio weather. Based on predictions for the 1951–1952 winter season, selection already has been made by RCA for the best working radio routes and frequencies to be used under the conditions forecast for that period.



Shown here is the critical grouping which would coincide with a severe period of disturbance.

tech engineering news

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from the editor's notebook

Our Present Danger . . .

The Struik affair dramatizes certain conditions existing in the country today which we find dangerous. The United States is coming perilously close to an attitude exhibited in Soviet Russia today. It appears that we are developing an intolerance toward ideas which are not shared by a majority of the people, and a tendency to make hasty accusations without the backing of factual information. This can be exemplified by the statement that Tech is a "hotbed of Communism" made last spring by a Massachusetts judge after hearing the totally unfounded report that there was a large May Day rally in front of the M. I. T. Dorms. We have reached a sorry state of affairs when a man who has been trained to be impartial and upon whose judgment the public is forced to rely can make such a groundless and violent attack. Such hysteria is dangerous because it has in the past, and can only in the future, lead to a loss of intellectual freedom.

There have been attacks on M. I. T. for its retention of Struik after he had publicly supported Marxist doctrines, but before he had been indicted. The School refused to discharge him until proved guilty. We believe that this insistence on academic freedom in the face of adverse public opinion is very commendable.

We realize that subversive elements must be eliminated, but that we must be careful not to persecute individuals with opinions which differ from our own, thereby losing those benefits for which we are willing to fight. There is a wide difference between the expression of ideals, unrealistic as they may be, and the advocacy of the violent overthrow of the government. The former is protected by American traditions, and is not detrimental to our national security. The latter can not be permitted in the name of free speech, since it would endanger that very freedom. It is on this basis, and no other, that Professor Struik should be judged.

S. K.
J. M.

Activities . . .

T. E. N., like other activities, is now looking for new staff members. Are you interested in writing? Freshmen do not need any specialized technical knowledge, as there is always room for an article of general interest. Possibly you lean to the business side of life. Then a position on the advertising, sales, or circulation staff might interest you. In any event, the *T. E. N.* office in Walker Memorial is open from 5 to 6 p.m. Monday to Friday. We'd like to meet you there soon.

In This Issue . . .

Charley Saltsman, our General Manager, has written an article of advice to freshmen. I believe it contains some controversial points, and would be interested in any comments by upperclassmen.

Rudolph Preisendorfer contributes another of his popular science fiction stories.

The article by **Dr. Gilmore** and **Dr. Farnsworth** (director of the Medical Department at M. I. T.) on mental tests should provide some food for thought.

Bert Krauss covers some little known points on a commonplace subject in his article on smells.

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the cost of an education

(*Continued from page 7*)

Baker House	$98.50
East Campus	92.00
Riverside	92.00
Fraternity	92.00

Because of the wide variation in service between these accommodations, corrections have had to be made to put all on an equal basis. For example, Baker House serves only 15 meals each week, East Campus and Riverside serve none, and the fraternities anywhere from 17 to 21. A cost of $2.00 a day has therefore been added for each day that meals are not served in various fraternities and dormitories, that being a reasonable estimate for obtaining meals elsewhere. The final results are as follows:

(1) Fraternity house bills, regardless of services, generally range from $84.00 to $100.00, averaging $90.56.

(2) Corrected to include room and board only, fraternities cost from $80.50 to $105.17, averaging $91.97.

(3) Dormitories (corrected for room and board only) range from $92.00 to $98.50, averaging $95.75.

From these results, it may be seen that the dorms, on the average, are more expensive than fraternities, and there is less variation from maximum to minimum. It must be remembered, however, that fraternities are social groups to which a member has certain obligations beyond those of living and eating. The national fraternities have national dues, and all have initiation fees. All present parties and other social functions, adding somewhat to the monthly house bills.

The average cost of living at Tech, including fraternities, dormitories, and boarding students, is very close to $90.00 a month. A school year runs for close to eight months. In other words, if you are not a commuter, you should plan to reserve approximately $720 to take care of room and board each year. This gives as a grand total, $1,563 for tuition, room, board, and fees. Allowing for laundry, books, transportation, and incidentals, you will find yourself spending from $1,700 to $2,000 each year. You may, by careful planning, pull this down to about $1,500. A four-year course at MIT will therefore cost from $6,000 to $8,000.

Time at Tech

As a freshman, you will soon learn that not only must you budget your finances, but you must plan your time just as carefully. The freshman schedule is, it must be admitted, a demanding one, but not so demanding that you will have to give up social life or activities. The following results were obtained from a student poll conducted by the *Tech Engineering News* in February of 1950. These figures are based on estimates submitted by 828 students, comprising 21.1 per cent of the student body.

(1) Time studying schoolwork

(2) Participation in extracurricular activities (including organized athletics)

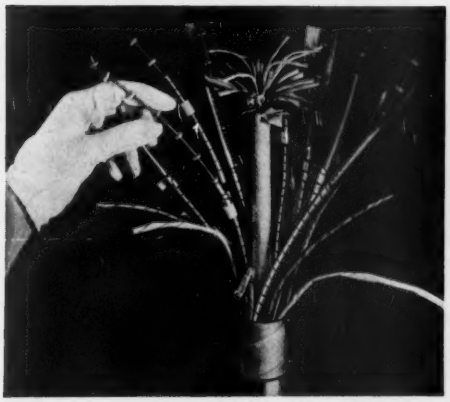
(3) Sleeping

(4) Planned social life

(*Continued on page 40*)

Newsworthy Notes for Engineers

Between the gloved fingers, you see the plastic discs which separate and insulate inner wire from outer tube of coaxial unit.



Plastic "life-savers" For Coaxial Cable

(ACTUAL SIZE)

In every mile of new eight-unit Bell Telephone coaxial cable there are over half a million little plastic insulating discs. They look simple enough—like small plastic "life-savers"—but there's a lot of engineering behind them.

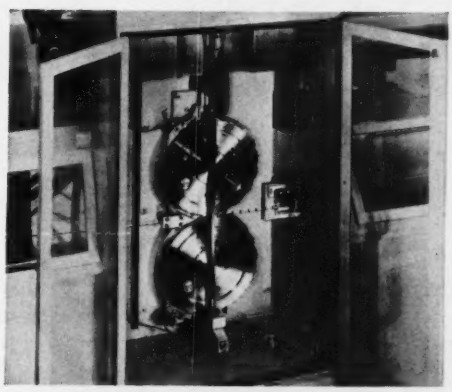
In early coaxials, the insulators were made of hard rubber. But scientists at Bell Telephone Laboratories found that polyethylene—because of its extremely low power factor and lower dielectric constant—reduced shunt losses to about one-twelfth of those with rubber discs.

Use of polyethylene plastic, however, required the development by Western Electric—manufacturing unit of the Bell System—of unusual handling techniques and special machinery.

Punching the discs, with a neat hole in the center, from sheets of the tough plastic is routine. To position them on the coaxial conductor accurately and speedily is not so simple. Equipment was designed and built which receives the discs from a hopper, forces each against a knife edge to slit it, and slips them on to the wire at regular intervals of one inch. At the same time another part of the machine forms copper tape into a tube around the wire and discs, gives a high voltage test, and wraps the tube with two spiral layers of steel tape to produce a completed coaxial unit.

Before the discs go into the machine, they are subjected to an "ozone atmosphere" and to the radiation from radium salts to remove static electricity which would cause them to stick together and refuse to enter the feeding tracks.

All of this – the development of new production methods and machines, the infinite care in manufacture – requires engineers of many kinds—electrical, mechanical, chemical, metallurgical, industrial. Working closely together, they help to convert scientific developments in communications into economically manufactured products for the Bell System.



Plastic insulators, fed into this mechanism, are slit – and pressed on to the coaxial conductor exactly one inch apart.

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the sense of smell

(*Continued from page 8*)

it is very fragrant as indicated by 7; slightly acid as indicated by 1; and slightly more burnt and capryllic, as indicated by the 2s. Using this method acetic acid is 3803, ethyl alcohol 5414.

Because we can distinguish odor intensity as well as a difference between odors the next step is to attempt to form some sort of percentile appraisal of them. The average human olfactory system cannot detect a change in odor intensity of less than thirty per cent. Some lower forms of animal life, however, can detect a slight increase in odor intensity. When moths, for example, fly to their mates they follow the trail of increasing odor intensity unerringly until they arrive at their destination. In order to provide a basis for odor measurement the minimum dilution of odor perceptible is called the M.I.O. number. This number proves itself useful in cases where odor is to serve as a warning of danger. It allows some standard to be set as to the minimum intensity requirements of such a warning agent. However, it is far from a satisfactory test basis for odors since it varies for different people.

Several devices have been invented for measuring odor intensity. Some of these, such as the Wells Osmoscope, which dilutes odors to various degrees of intensity, depend on the human factor in the long run. Others, such as the "scent meter" used by fox hunters, merely indicate conditions such as temperature, humidity, wind direction and air motion. That is, it indicates favorable or unfavorable conditions for hounds to pick up a scent, but it is by no means an actual odor measuring device.

Unpleasant odors have been the cause of many legal suits, and considerable expenditure on the part of the government and industry. Despite common opinion to the contrary, odors cannot cause organic disease. Frequently, of course, conditions which do cause it are accompanied by unpleasant odors. Physicians once believed that odors given off by swamps were the cause of typhoid and it is probably from this idea (proven false long since) that this misconception arose.

The odors of such poison gases as hydrogen sulfide and chlorine are themselves not toxic. On the contrary they prove themselves helpful by serving as warning agents. Carbon monoxide, for example, is odorless and extremely toxic while acetone has a strong odor and is harmless.

Odors, although not toxic, have some effect on health. Slaughterhouse workers and others who are exposed continually to sharp odors can eat their meals oblivious of their surroundings. Yet, an experiment conducted in New York City has shown that bad odors lower food consumption about five per cent. It has also been noted that visitors who are not accustomed to obnoxious odors of certain industries cannot partake of food while they are exposed to the odors.

While it has been shown that odors cannot cause

(*Continued on page 22*)

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The great progress made in American chemistry has been in the past 30 years . . . within the lifetime of most of us.

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Vision—75 Years Ago

Though the greatest advances have been made within three decades, the foundation for this progress was laid by the pioneering American chemists who 75 years ago had the vision to form the American Chemical Society. Their society has grown from a handful of members to well over 60,000—the world's largest professional scientific organization. The people of Union Carbide are glad to pay tribute to the American Chemical Society on its Diamond Jubilee, and on the occasion of the World Chemical Conclave.

Union Carbide Grows With Science

Chemistry and the related fields of physics and metallurgy have long been major interests of Union Carbide. The application of these sciences to producing new and better materials has been the backbone of UCC's growth.

FREE: *Learn more about the interesting things you use every day. Write for the 1951 edition of the booklet "Products and Processes" which tells how science and industry use the ALLOYS, CARBONS, CHEMICALS, GASES, and PLASTICS made by Union Carbide. Ask for free booklet L.*

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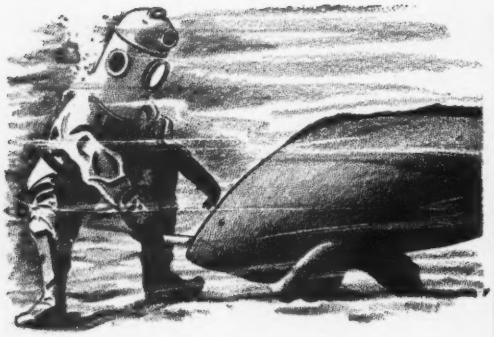

The wonders of the ocean's floor are duplicated in two giant tanks at Marine Studios, at Marineland, Fla. More than 30,000 live undersea specimens are presented in their natural setting, and into these tanks are pumped more than 7,000,000 gallons of sea water per day.

Okolite-Okoprene cable was selected as the most reliable means of supplying power to the motors which pump this water. Power is taken from a 2300-volt circuit and stepped down to 220-110 volts, for motors ranging from ¼ to 30 h.p.

The corrosive influence of salt water and salt air has virtually no effect on the tough Okoprene sheath which protects Okolite-Okoprene cable.

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Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

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Buffalo's Largest Store Air Conditioned throughout with Frick Refrigeration

All Departments are Air Conditioned

Sattler's Department Store, covering most of a large city block, serves up to 150,000 people in a single day. The giant store is cooled in hot weather with ten Frick ammonia compressors using 920 horsepower. Installation by Mollenberg-Betz Machine Company, Frick Sales Representatives at Buffalo, N. Y.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

Ten Frick Compressors Installed on the Roof of Sattler's Store at Buffalo

FRICK CO. WAYNESBORO, PENNA. U.S.A.

Also Builders of Power Farming and Sawmill Machinery

the sense of smell

(*Continued from page 20*)

disease or seriously affect food consumption, they are an important factor in our health. Through the psychological factor bad odors can cause vomiting, loss of sleep, anger and the attending ill effects. It is for these reasons that they must be prevented and controlled.

Industrial odors have been known to travel as far as fifty miles under favorable meteorological conditions. Usually, however, they will not be effective over a radius larger than two miles.

Topographical conditions have a definite effect on odor propagation. A plant located in a valley will affect an area located on the top of an adjoining hill, but an area on the other side of the hill will be protected. These conditions will, therefore, play an important part in choosing a site for many industrial plants.

Temperature and humidity also affect the odor density. The greatest effects are felt during the evening. The dropping temperature prevents updrafts which would otherwise carry the odors away and also causes fog to form which dissolves the odorous gases and keeps them close to the ground.

Aside from industrial and natural odors in the outdoors we must deal with the indoor variety which is caused primarily by such human activity as perspiration, respiration, smoking, and cooking. The problem of replacing stale indoor air with the fresh outdoor kind, or at least with a more pleasant odor, is by no means a new one.

The ancients, who had no ventilation systems, frequently resorted to burning incense in order to mask unpleasant odors. At the present time there are several similar products on the market which claim to bring the smell of fresh outdoor air into the home.

Besides these, such items as perfumed soaps, perfumes, and tooth pastes mask various unpleasant body odors. Soaps and tooth pastes not only remove the odorous bodily wastes, but emit a fragrance which masks those odors produced afterward. Not all masking agents are used to produce a pleasant odor. The purpose of many is only to cancel any undesirable ones.

To animals the olfactory system is of utmost importance as a danger signal. Those giving off offensive odors use it as a means of self-defense as well, and prey upon the sensitivity of other creatures for its effectiveness. Unpleasant odors have always been a warning of danger to humans as well as the lower species of animal life. This ingrained association of unpleasant odors with danger makes them valuable to us as warning agents. They serve as alarms in underground wires and as warnings of fire and explosions. The choice of a proper agent is by no means a simple task. There is more to it than picking any foul-smelling chemical and mixing it with the gas. The warning agent itself must be completely harmless, yet effective; it must not corrode any of the pipes or equipment it moves through.

Unpleasant odors can be used as repellents to various insect pests. The oldest and perhaps most common of these is citronella. During the last war, due to the great need for them, many new repellents were developed. Among these were not only insect repellents but some for sharks as well.

The field of olfaction is a rapidly expanding one. New olfactory materials, new uses for them, new ways of using old ones and new knowledge of the principles of olfaction are being discovered and developed at a rapid rate. The senses of hearing, sight, and taste have all been catered to. The era of the nose is soon to come.

What makes the world go 'round?

These fast-moving times might well go down in history as the "Age of Transportation"... Today, people are able to enjoy goods delivered from places once wholly inaccessible. It is easy to visit friends many miles away. Doctors quickly reach the sick; country children enjoy the benefits of bigger schools in distant cities; industry is constantly expanding to supply you with more goods in less time—all through modern transportation by land, sea and air.

All this has been made possible largely by the rapid development of the internal combustion engine — powered and lubricated with petroleum products. Esso Standard Oil Company is proud of the part its 27,000 employees have played in producing better petroleum products for better transportation. And our regular good jobs policy—with fair pay, a chance to get ahead in the Company and many employee benefits—has helped us to get *good* people on the job.

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K+E

Drafting, Reproduction and Surveying Equipment and Materials, Slide Rules, Measuring Tapes.

ostheimer's rule

(*Continued from page 13*)

still see Nikkersson when the little professor came to Bellshaven Hall in Oraibi the day after the announcement. He came up the concrete steps, perspiring, carrying a small black leather brief case under a sweat-drenched suit jacket, his small bald head glistening in the feverish sun, the ineffectual smile under his thinning mustache. Nikkersson was a small, quiet, unassuming being, one who would have been stepped on in a pneumatic tube rush; or who could have donned a clerical robe without anyone being the wiser. Ostheimer recalled the purpose of Nikkersson's visit, and with quickening pulse, recalled the little man's words, words which opened to Ostheimer and his men the possibility of traveling to the stars, not with the plodding majesty of a chemical, or atomic powered rocket, but with the breath-taking, whisking, light-year shattering strides of the Nikkersson drive. For, what was done with the little copper cube, argued Nikkersson, could just as easily be done with a thirty-ton spindle of aluminum, steel, and human flesh. And he argued correctly. Just about.

Both Nikkersson and Ostheimer were dreamers. One a theoretical dreamer, the other a practical dreamer. One's theory and the other's practical experience went hand in hand, and under their combined efforts the final curtain on man's traveling destiny was lifted.

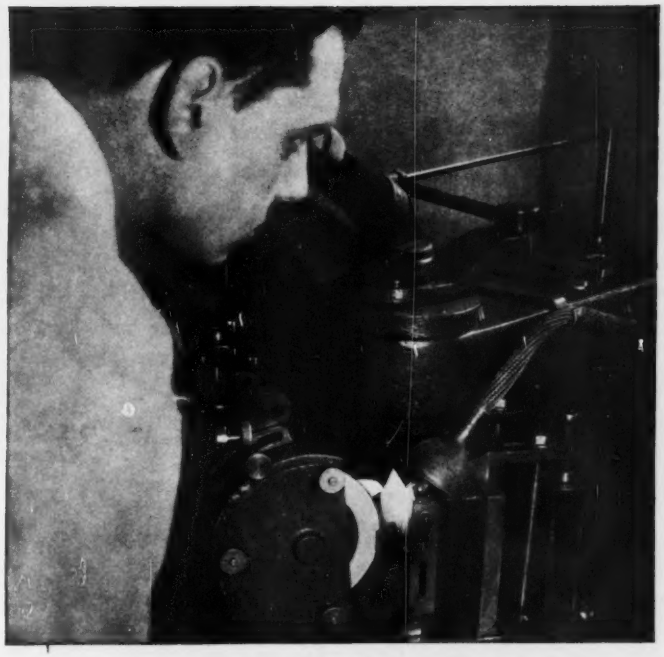
The April morning in 2006 in Oraibi was dreary and blustery. The sands whipped fretfully about equipment and men. Some of the original piquance of a similar morning six years ago was lost. But in its stead stood adventures, horizons, and dreams unbound. Still, Ostheimer recalled, the uneasiness of the men, the unusual reticence of Nikkersson, and his own feeling of trepidation were strangely prophetic. Even the weather seemed somehow to sense the awful drama of the next few minutes. Ostheimer shuddered as he recalled the launching. It really couldn't have been called a launching, for, one instant the spherical ship was there, and the next instant there was a frenzied whirlwind of disturbed sand circling violently into the vacuum left by the craft. That was all right, yes, that was fine. But their unspoken fears materialized in the next instant. The directed radio pickups had recorded an enormous radioactive explosion on the Moon. That wasn't on the schedule. It shouldn't have happened. There was something strangely awry, something enormously sinister about that recorded explosion . . . that the radio pickups were correct, was accepted without a doubt . . . there was a strange wrongness about that explosion. For there was nothing, absolutely nothing, radioactive on the ship that went up there. There was left in the minds of Nikkersson, Ostbeimer, and the men, a vacuum of uncomprehension as deep as that left by the departing ship. Ostheimer rubbed his tanned face with a tired hand, ran his fingers gently through his silvered hair, and shook his head as he recalled that dark moment forty-five years ago. Why hadn't he or Nikkersson seen what the trouble was? Nikkersson, most of all, should have been able to ferret out that ominous secret, but it just didn't happen that way. Somehow, he, Ostheimer, was destined to open the doorway to the stars after all. Maybe if Nikkersson lived just a bit longer, he would have fathomed the problem . . . yes, indeed, he would have, and maybe many brave lives and millions of dollars would have been saved.

Ostheimer's memories had the texture of dark, burnt-paper ashes, and fixing them would only crumble them into unclarity again. He recalled dimly the construction of the second ship, and its launching a year after the first one. The radioactive puff of brilliance which shone from the darkened side of the New Moon still burned its magnified flame into his eyes forty-four years later. The second went the same as the first. And the third. Then Nikkersson's genius seemed to solve the problem. A fourth ship was constructed, and in the summer of 2008 it was launched. Nikkersson had devised automatic timers and related equipment necessary to guide the fantastically fast ship automatically about a closed path. It swung out into deep space, they estimated, a distance of four light-years, cut power, turned about and returned to Earth, landed intact. That was a bright spot in Ostheimer's memory train. The shadowy spectre of failure seemed momentarily dispelled at the time. Nikkersson, he recalled, was jubilant, and he immediately started to plan a trip to Mars with the ship. It seemed a long way off, but the drive would make it, they calculated, within seconds.

(***Continued Next Month***)

Who Is He?

- ☐ *a metallurgist*
- ☐ *an expert toolmaker*
- ☐ *a laboratory technician*



If you checked "toolmaker", you know your way around in a machine shop. He's grinding the contour of a carbide-tipped flat form tool on an optical-type precision grinder equipped with a Norton Diamond Wheel.

Facts You Should Know

One of the reasons for the industrial edge the United States has over other countries is its leadership in the use of cemented tungsten carbide tools. With them, American industry has speeded up mass production.

Cemented carbide tools are so hard that they cannot be machined in their ultimate form by any known metal tool. So, they must be shaped by grinding with abrasive wheels.

Diamond wheels have become the accepted type of abrasive wheel for precision grinding operations on cemented carbides. Their exceptionally fast and cool cutting action and extremely low rate of wear result in economically low grinding costs.

Norton Diamond Wheels

Norton Company pioneered in the development of diamond wheels in this country, bringing out the first Resinoid Bonded Diamond Wheel in 1934. This was followed 5 years later by the durable Metal Bonded Diamond Wheel. And in 1945, came the Vitrified Bonded Diamond Wheel, a development of the Norton research laboratories.

Today, the Norton price list for Diamond Wheels and Hones contains about 1000 items, ranging in list price from $17.70 to $2,877.35, depending on the size of the wheel and the diamond content.

Think It Over!

Because Norton Company is dedicated to "making better products to make other products better," Norton Research is always looking ahead. To the young technical man, such a progressive attitude promises an interesting future.

Free Handbook On Grinding Carbide Tools describes in detail how Norton Diamond Wheels are used to recondition and sharpen cemented carbide tools and cutters rapidly and economically. Write for a free copy.

Joseph C. Danec, B. S. Ch.E., Lafayette College '39, examines a diamond wheel section with Bausch & Lomb Research Metallograph in connection with his work on the development of Norton Metal Bonded Diamond Wheels.

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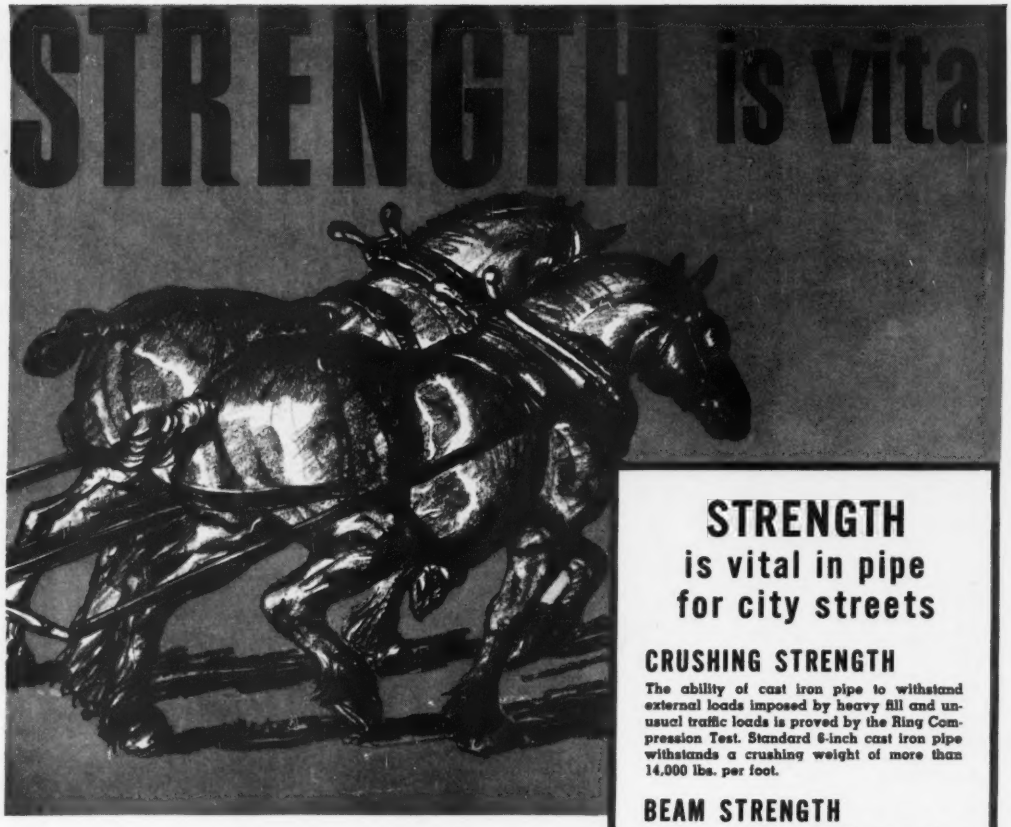
STRENGTH is vital



STRENGTH
is vital in pipe for city streets

CRUSHING STRENGTH

The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

BEAM STRENGTH

When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

SHOCK STRENGTH

The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

BURSTING STRENGTH

In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

Be doubly sure when you specify pipe for mains to be laid under city pavements. Sure that it effectively resists corrosion. Sure, also, that it has the four strength factors, listed opposite, that pipe must have to withstand beam stresses, external loads, traffic shocks and severe working pressures. *No pipe, deficient in any of these strength factors, should ever be laid in paved streets of cities, towns or villages.* Cast iron water and gas mains, laid over a century ago, are serving in the streets of more than 30 cities in North America. These attested service records prove that cast iron pipe not only assures you of effective resistance to corrosion but all of the vital strength factors of long life and economy.

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So important is this area of military intelligence that RCA Service field engineers have lifted their efforts to new peaks. Working with our Armed Forces, they install and maintain such *communications systems* as shortwave radio and portable radiotelephones. They work with systems of *detection*, such as radar. They help ships and planes *navigate* with loran and shoran. These engineers are the link between research developments made at RCA Laboratories—and America's military strength.

The number of RCA field engineers has *tripled* since World War II. And they serve where needed, wherever an electron tube's "military mind" can be of military use.

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RANGER

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psychological diagnostic service

(*Continued from page 14*)

a result of training but was something with which he was born. We now know that this is not true. Unusual achievement in any one field is usually the result of good general ability in addition to training and a desire to excel in that special area. The term aptitude test, then, is not a sufficiently accurate descriptive term of the psychological testing procedures that are carried on currently by up-to-date psychological services. Sometimes the student voices disappointment in these tests because they have not informed him of some very special thing that he could or should do. Since the two greatest factors in achievement are good general ability and motivation, the current approach to measurement and diagnosis is to place emphasis upon the person's general ability, upon special skills that may contribute to his effectiveness as a student such as reading and arithmetical skills, and to diagnose, if possible, the emotional drives that may be impelling him to succeed or fail. Thus, a student with good general ability should be able to do successfully nearly anything that he desires if the need for achievement in that special area is sufficiently great.

There are approximately five different areas or phases of individual behavior that can be measured by current psychological tests. The first area is that of general ability or general intelligence. Into this classification fall the more or less common I.Q. tests that nearly every student has taken or at least has seen sometime. The so-called I.Q. tests are among the earliest to be developed in the field of psychological measurement. These tests usually place a high premium upon verbal skill, reading ability, arithmetical skill and speed of working. They are divided into two broad categories — the group tests that can be administered to a large number of students at one time and the test of intelligence which is administered by a trained examiner to the individual student. The handicaps of reading skill and a tempo of working are lessened considerably in the individually administered test, and for that reason the psychological service uses almost routinely the Wechsler-Bellevue Scale of Intelligence. This particular test has two parts — one based on verbal skill and the other on performance. The verbal part places more emphasis upon reasoning skills which may be closely related to academic achievement. Attention and concentration ability as well as judgment are diagnosed by the verbal part. The performance part places a little more emphasis upon manual skill and upon general non-verbal abilities. The skilled psychologist can also secure from the individual performance of the student on the Wechsler-Bellevue indirect information about his habits of working. Because of certain limitations the group tests of general ability are used quite infrequently in the psychological service.

The best current group test of general ability is the civilian edition of the Army General Classification Test. This is sometimes used to secure a general level of ability when speed is essential. It should be noted that the term I.Q. is losing favor in psychological circles, and the term "point score" is being substituted. Furthermore, a score or I.Q. should be related to the specific test from which it was obtained.

The second general area of psychological measurement is known as special abilities. It is this area to which the term aptitude test has been applied in the past. It is here that the individual, because of his interest, motivation, and opportunities for learning, has developed a special skill. In spite of the emphasis upon special abilities, the tests in this area are not nearly so satisfactory nor so trustworthy as some of general ability. These have in many instances functioned as tests of achievement rather than of special endowment. If a student has made a poor record on one or more of these special abilities tests, the psychologist has learned not to rely on this as being indicative of certain failure in that skill. For students at MIT the special test that is usually used is the Stanford Scientific Aptitude Test. This instrument measures some of the skills and working habits that are peculiar to people who have been successful in the field of science. It also measures judgments, deliberations and a certain amount of chance taking that may or may not be peculiar to the successful scientist. It usually correlates rather well with general ability, but there are some exceptions. Some aptitude tests in the manual skills have little usefulness for the average MIT undergraduate and for that reason are seldom used.

The third area of psychological measurement is that of academic skill. In order to do successful college work, the student must be able to read effectively. In an engineering school he must be able to have considerable proficiency in mathematics and related skills. In measuring the reading efficiency of the student the element of time is important; therefore, in the psychological service there are two tests of reading skill given routinely. One is the Cooperative Test, which measures the student's general literary vocabulary, his speed of reading, and his level of comprehension on the material that he has read. This is a time test which requires about forty minutes and is a relatively good measure of the student's skill when the time factor is involved.

(*Continued on page 32*)

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There's a proper Roebling wire rope for every requirement. The Roebling Field Man is always ready to recommend the best rope for economical performance on any operation. In addition, his suggestions on the proper installation, use and maintenance of wire rope often bring further substantial savings. John A. Roebling's Sons Company, Trenton 2, New Jersey.

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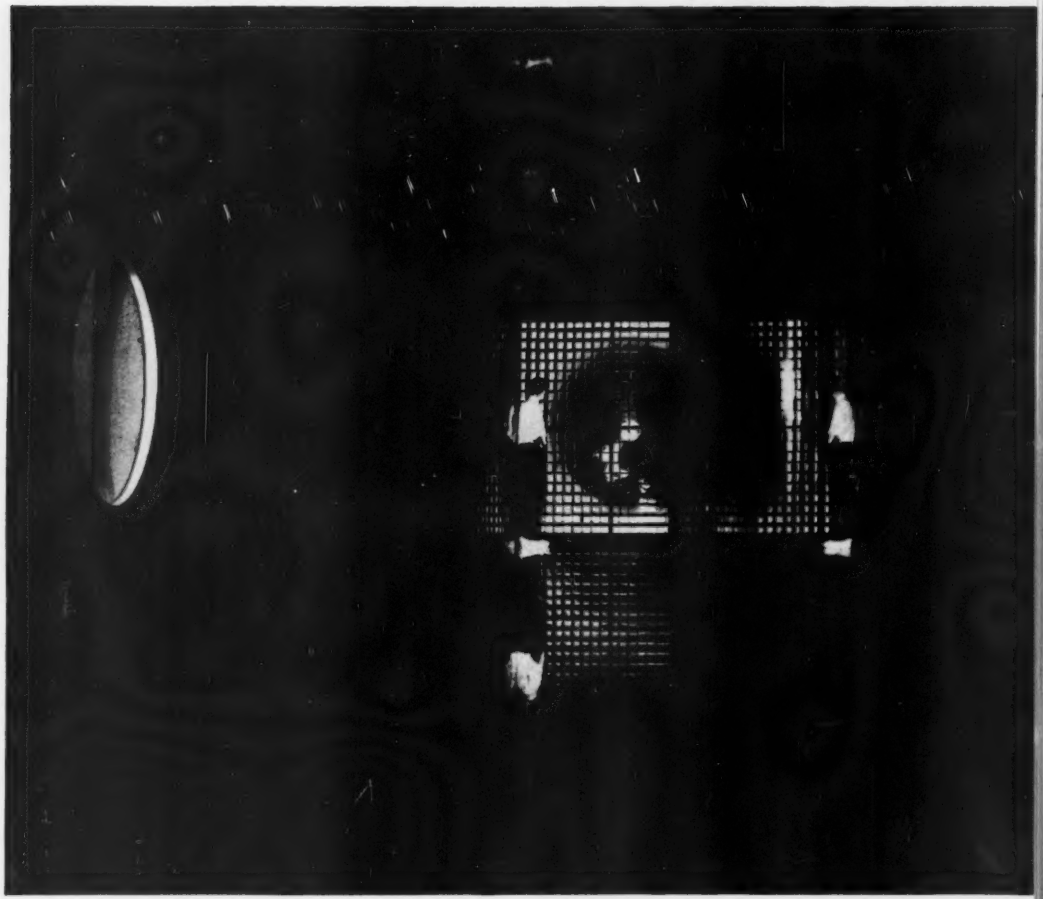

CAVE OF THE WINDS. This largest "supersonic" wind tunnel in the world—at the National Advisory Committee for Aeronautics, Lewis Laboratory, Cleveland—is capable of providing air velocities up to twice the speed of sound for aeronautical research. The tunnel's testing chamber measures 8 by 6 feet, and has flexible walls of highly-polished U·S·S Stainless Steel plates, specially made by U.S. Steel for this vital defense project.

NEW WAY TO GATHER GOOBERS. This new peanut combine threshes along the row where the peanuts are grown, gathers up nut-laden vines, picks them clean, and deposits the mulch to condition the soil for the next crop. In tests, it has reduced harvesting man-hours per acre from 30 to 4, lets two men do the work of 12, saves $40 an acre. By supplying steel for such equipment, U.S. Steel helps build a more productive America.

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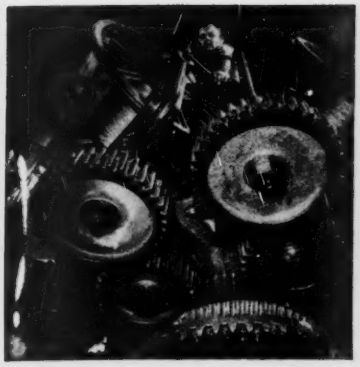
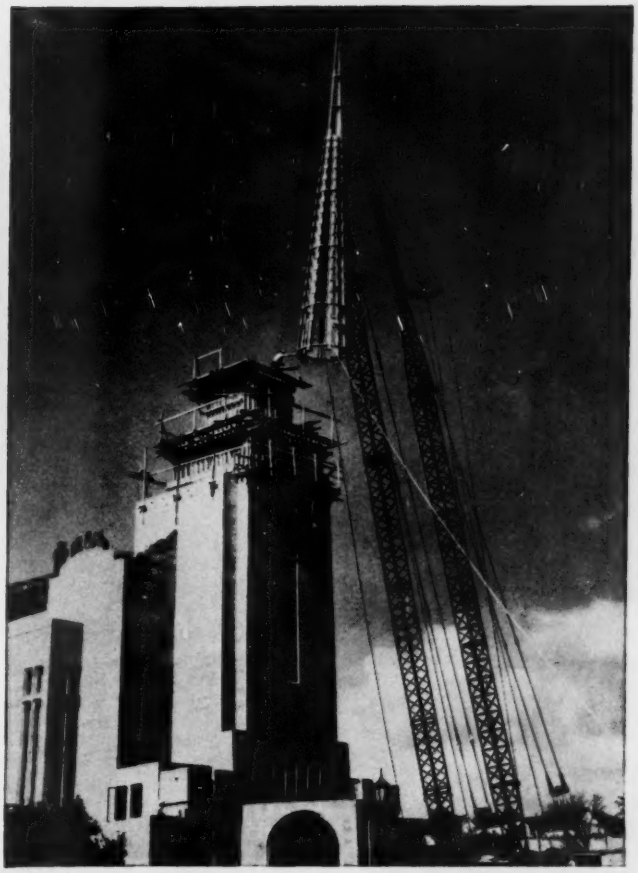
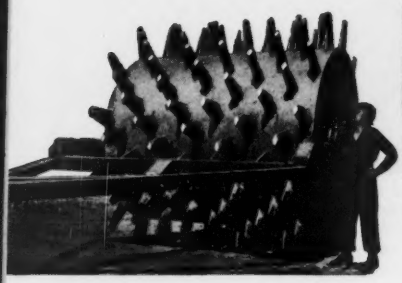


WHEELS WITHIN WHEELS. Here you are looking into the driving gears of a 10-ton vertical closing machine, making U·S·S TIGER BRAND Elevator Rope to lift and lower the elevators in many of our country's famous skyscrapers. This equipment also manufactures general hoisting rope for applications such as the cranes shown in illustration at right. Whether you need enormous steel cables to support a bridge, or wire that's finer than a human hair, United States Steel manufactures a wire suited to your special requirements.



HOW TO SWING A STEEPLE 80 FEET UP. Here are two cranes completing the 80-foot lift of a prefabricated steel steeple, and about to swing it over its base. United States Steel has won a world-wide reputation as fabricators and erectors of steel work for everything from football stadia to church steeples, from bridges to television towers.



GIANT SHEEPSFOOT ROLLER. Army Engineers find this odd-looking, 36-ton steel roller a very useful tool for compacting and leveling off fill in the construction of airstrips. Although the defense program will require increasing amounts of steel, the constantly-expanding steel-producing facilities of United States Steel should enable it to supply steel for many essential everyday uses, too.

FACTS YOU SHOULD KNOW ABOUT STEEL

In 1951, the American steel industry must be able to purchase 30 million tons of high grade scrap *outside* the industry, if it is to achieve the record steel production goals set for it by our defense program. Memo to manufacturers, farmers and proprietors of auto "graveyards": Turn in your scrap! It means money for you, more steel for America!

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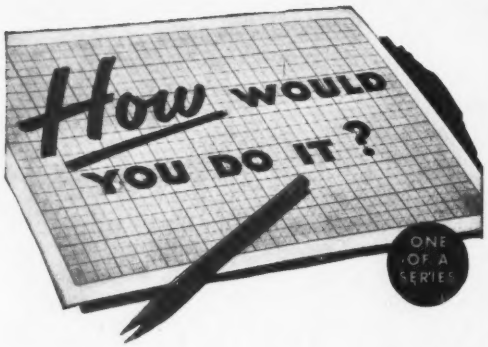
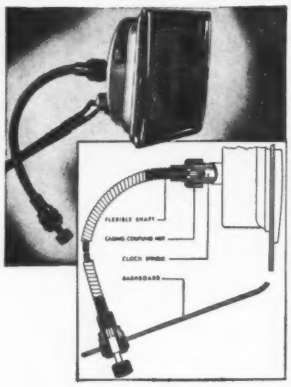


PROBLEM—You are designing an electric clock for automobiles. The clock itself is completed. To set the clock, the spindle which turns the hands must be pushed in against a spring pressure and then turned—and, of course, when the clock is installed, this spindle is back under the dashboard. You want to provide a means for pushing and turning the spindle from a point that is easy to get at. How would you do it?

THE SIMPLE ANSWER—Use an S.S.White flexible shaft The illustrations show how one manufacturer does it. Regardless of where the clock is mounted, the flexible shaft, available in any length, makes it possible to put the hand-set knob in the most convenient spots.



★ ★ ★

This is just one of hundreds of power drive and remote control problems to which S.S. White flexible shafts are the simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles"* for mechanical bodies.

*Trademark Reg. U. S. Pat. Off. and elsewhere

WRITE FOR BULLETIN 5008

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours free for the asking. Write today.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO. Dept. C, 10 East 40th St. NEW YORK 16, N. Y.

psychological diagnostic service

(*Continued from page 28*)

There are many students who are slow readers or are annoyed by the pressure of time and yet may be quite effective as students. For that reason another test, the Ohio State Psychological Test, which does not have the factor of time, is used as a second measure of reading skill. In this, the student can work as long as he wishes. Among MIT students the extremely fast and efficient reader may not have any higher academic record than the slow reader because of the nature of the material that is to be read and because many courses may not require extensive reading. However, the student who reads slowly will find that his ease of working increases considerably with increasing reading speed. He should also have a speed of reading that is flexible and which can meet the demands of the various kinds of material that he may read from time to time. Among Tech students the problem of mathematical skill is not a great one. In some cases where there may be some doubt, the Cooperative Mathematics Test is given, but it is not in the battery that is used routinely.

The fourth general segment of psychological measurement is known as interest testing. Interest tests can be classified into two groups — the vocational and the academic. The academic indicates a preference for certain subjects in high school or college. The two phases overlap to some extent because the academic courses the student selects are usually related to his vocational interest. As a matter of fact, a certain vocational interest requires that the student take special courses. There are many misconceptions about an interest test. It is not an ability test although there seems to be a rather close relationship between the interest that the person manifests and the ability to be successful within that field. In other words, few students have interests in fields for which they do not have ability. A second limitation of interest tests which is not always obvious to the average student is that these instruments are not sufficiently refined so that any psychologist can tell whether the individual should pursue a specific task or specialty within general broad areas. For example, it would be rather difficult for any psychologist to tell whether a student who manifests an interest in the field of art should be an architect, a portrait artist, or a commercial artist. The closest that the vocational tests can come to accurate measurement of interest is to indicate preferences for rather broad vocational areas such as engineering, science, fine arts, work that may involve contact with people, clerical work, outdoor activities, and possibly work that would involve social service. It has been found that the average MIT student who is manifestly interested in studying science or some phase of engineering usually is high in the general areas of mechanics, mathematics, and science. From observation it appears that those persons interested in chemistry and physics are highest in the field of science and probably second highest in the computational field. Another use of vocational testing, or specifically the standard Kuder Preference Test, is to give some indication of the emotional adjustment, goals, and drives of the individual. A glance at the Kuder Profile can give some idea as to whether the person is clear-cut and definite in the goals he wishes to pursue. A lack of definite likes or dislikes in the area of vocational choice suggests a certain amount of indecision, confusion and dilemma that may carry over to other phases of his life. The Strong Vocational Interest Test is another that is used for the purpose of further

(*Continued on page 36*)

It seems that many people have a misconception of the term "Abrasives."

To summarily describe the product of the abrasive industry as only "sandpaper" is no less limiting than to define the multi-product dairy industrialist as a maker of cottage cheese.

It is true, of course, that we do make "sandpaper"—from the kind you buy in a hardware store for general use at home to the kind used to obtain a superior ultra-low, micro-inch finish on a high precision machine or tool. As a matter of fact —only CARBORUNDUM makes all abrasive products. Bonded abrasives ...such as grinding wheels, sharpening stones and sticks. Coated abrasives... such as sheets, belts, discs, rolls and sleeves. Grain for polishing, blasting and finishing. And a host of related products. Furthermore, there is hardly a business or industry which does not use abrasives. For abrasives cover the tremendous range from a tool sharpener to a production tool.

Only CARBORUNDUM

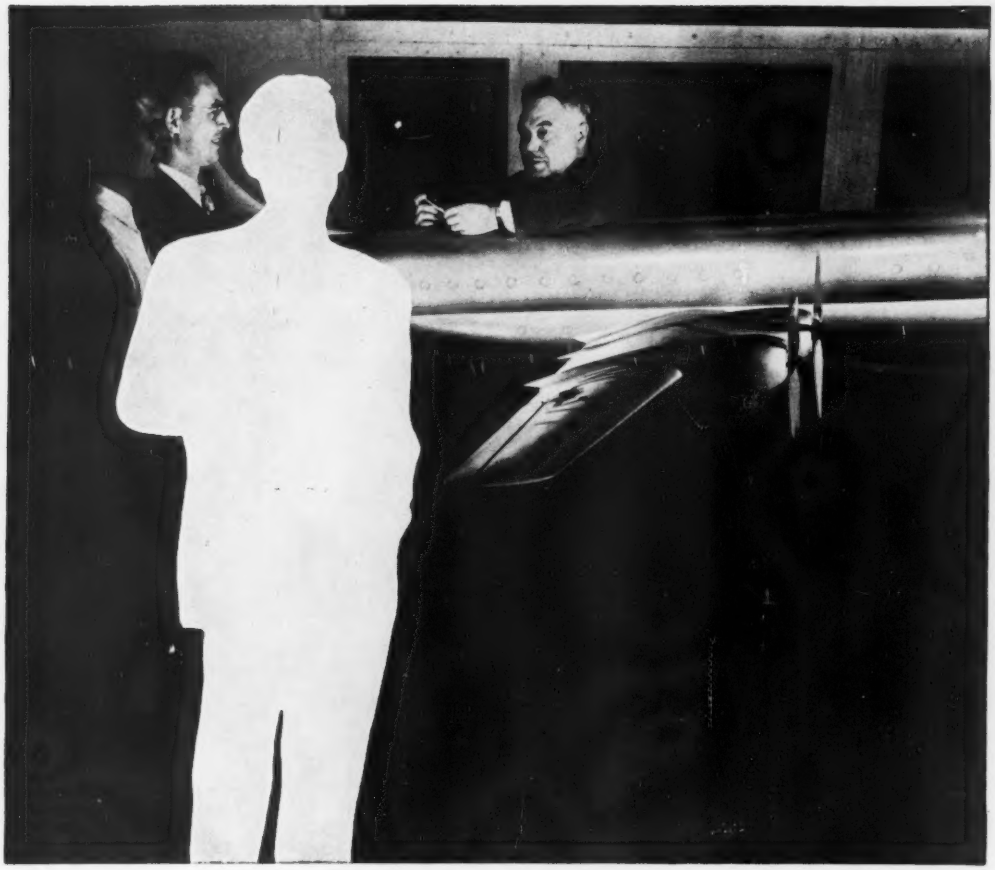
TRADE MARK

makes ALL abrasive products to give you the proper ONE

Also manufacturers of Super Refractories • Porous Media • Heating Elements • Resistors • Deoxidizers

"Carborundum" and "Aloxite" are registered trademarks which indicate manufacture by The Carborundum Company, Niagara Falls, N. Y.

80-11



Do you fit in the Boeing picture?

Boeing's world-wide reputation for sound engineering achievement is founded on *men*. Boeing engineers and physicists are graduates of many universities and technical schools. They come from every state in the Union. Under inspiring leadership they have been welded into one of the most potent forces in any field of scientific advance.

If you can measure up to Boeing standards, there is an attractive future for you in this renowned group. In addition to the prestige which attaches to being a member of the Boeing engineering team, there are other definite advantages:

1 The challenge of working on such vital programs as the B-47 and B-52 jet bombers, guided missiles and other revolutionary developments.

2 Stability of career opportunity with an engineering division that is still growing steadily after 35 years.

3 The invigorating atmosphere of the Pacific Northwest — hunting, fishing, sailing, skiing, temperate climate all year around.

4 Good salaries. And they grow with you.

5 Moving and travel expense allowance.

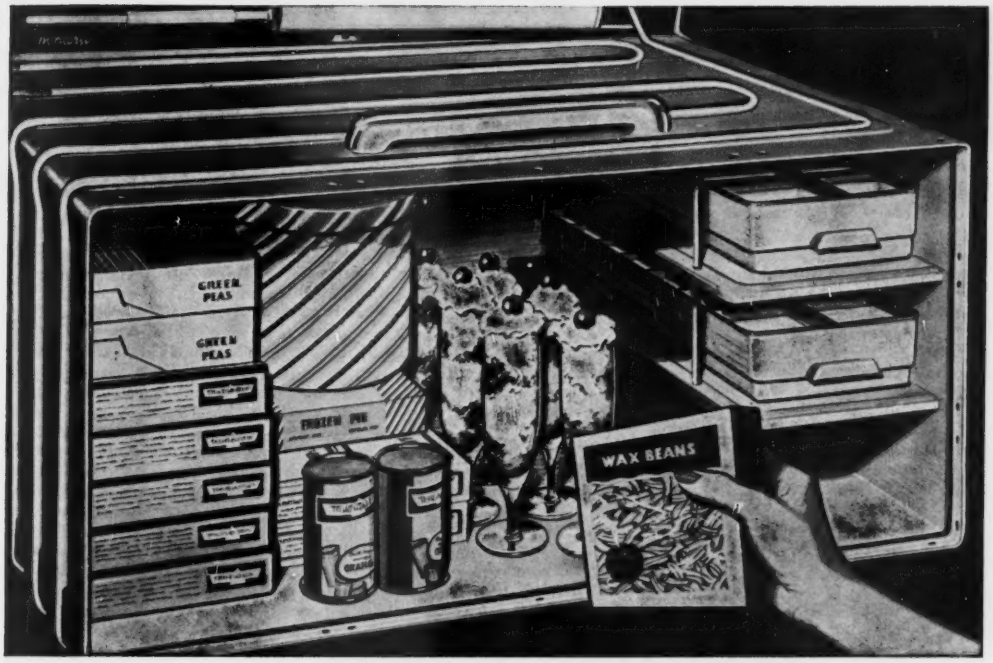
6 If you prefer the Midwest, similar openings are available at the Boeing Wichita, Kansas, plant. Inquiries indicating a preference for Wichita, Kansas, will be referred to the Wichita Division.

Boeing's immediate needs call for experienced and junior aeronautical, mechanical, electrical, electronics, civil, acoustical and weights engineers for design and research; for servo-mechanism designers and analysts; and for physicists and mathematicians with advanced degrees.

Write today to:

JOHN C. SANDERS, Staff Engineer—Personnel
Boeing Airplane Company, Seattle 14, Wash.

BOEING



YOU COULD EXPRESS THIS PROBLEM AS

$$\frac{(\text{Temperature}) \times (\text{Corrosion}) \times (\text{Fabrication})}{\text{Cost}}$$

The day after VJ-Day, engineers from a leading appliance manufacturer showed us plans for their postwar refrigerator with a great new feature—*a king-size freeze chest.* But the size increase threatened prohibitive costs. And no combination of metals so far had satisfied the requirements: Fast heat transfer; corrosion resistance; ease of fabrication. They asked, "Can we do it economically in aluminum?"

Now the freezer is simply a sheet metal box with passageways around it to conduct the refrigerant. Knowing that aluminum is an excellent conductor of heat, we suggested that the evaporator be made by brazing aluminum tubing to aluminum sheet. "Sounds good," they said and together we started designs.

Aluminum Research Laboratories found the answer to the first important question: Aluminum is compatible with most commonly used refrigerants.

Alcoa's Process Development Shops suggested an amazingly simple fabrication process, "Place the tubing on flat brazing sheet and furnace braze the assembly. Then form the unit into box shape." The first 25 units were made in this manner—a process so practical and economical that it hasn't changed since. You'll find aluminum freezers, formed by this method, in a great many refrigerators today.

This case is typical of the problems Alcoa men undertake and solve. Throughout the Alcoa organization, similar challenging jobs are in progress and others are waiting for the men with the imagineering ability to solve them.

ALUMINUM COMPANY OF AMERICA, 1825 Gulf Building, Pittsburgh 19, Pennsylvania.

A business built on co-operation

ALCOA®

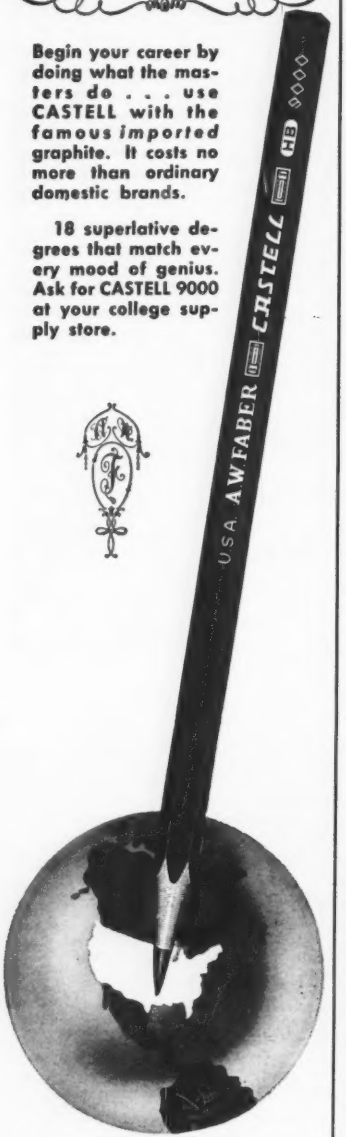
ALCOA

ALUMINUM COMPANY OF AMERICA

USE THE WORLD'S BEST at NO EXTRA COST

Begin your career by doing what the masters do . . . use CASTELL with the famous *imported* graphite. It costs no more than ordinary domestic brands.

18 superlative degrees that match every mood of genius. Ask for CASTELL 9000 at your college supply store.



AW FABER-CASTELL
PENCIL COMPANY INC. NEWARK 4, N.J.

psychological diagnostic service

(*Continued from page 32*)

clarification of the individual interest. This test is somewhat complicated and expensive to administer and is not used routinely. It compares the individual's interest and background with people who have been successful in various special fields. These special fields are further classified into general areas such as science, engineering, sales, literary, and others. Usually there is a close agreement between the Kuder and the Strong Tests.

The fifth general area of psychological measurement is that of emotional adjustment or, as it has been called in the past, personality testing. It is this area of testing that is particularly valuable and fruitful to the psychologist. At the same time measurement in this field is also less accurate than in the others, and the possibility of error is large. Due to the many complicating factors and variables that affect the individual's functioning, the existing statistical methods are not as precise as they are in the field of general ability. The first tests in the area of emotional adjustment were those that were roughly classified as paper and pencil questionnaires. A person answered "yes" or "no" or "doubtful" to certain statements that were aimed at a special reaction or emotional reaction under a particular circumstance. Most of the questions dealt with the relationships between people and among individuals, and the attempt was made to find out how the individual reacts to situations that involve other people.

The instruments now used in this field are those known as projective tests. The underlying idea of projection is not particularly new; it is simply the process of looking objectively at one's own thoughts. It is something that is going on within the average human being every hour of the day. There is a certain amount of inevitability about projection; that is, we project our emotional reactions on our fellow associates and our environment continuously. The projective test merely crystallizes, focuses, and to some extent objectifies this projective process in which the individual is constantly engaged.

The two projective tests that are used most widely by the psychological service are the Sentence Completion Test and the Thematic Apperception Test. In the former, the person is given a phrase or part of a sentence and asked to complete it. The statement that he puts down is theoretically peculiar to him and will indicate to some extent how he will react in a certain situation. The Thematic Apperception Test requires the person to write a story about ambiguous pictures, and his characteristic reactions are noted. These projective tests indicate an individual's methods of defending himself and the ways in which he reacts to other persons in his efforts to feel safe and secure. These tests are particularly helpful in getting at the student's needs. They often give insight into the solution of the problem of a student's choice of course and of school as well as his efficiency.

As has been stated before, psychological tests do have certain definite limitations. In all the fields of science and measurement, there is probably none in which there is as much room for error as in the measurement of the human being. The errors occur in five general areas. They are very apt to appear in the individual who is taking the tests. For one reason or another he may not be working up to his ability. The second general area of error is in test construction. The test may not be constructed in a very accurate manner or its so-called standardization may not be very accurate, thus giving a false impression of the student. The third area of mistakes can be made in the administration of the test. The person who gives the test may not be sufficiently trained or for some reason may not be functioning as well as he should be. Furthermore, even though the test may be scored objectively and quantitatively, there are errors that can creep in. The last place where errors can occur is in the interpretation of the test results. This is particularly true in projective tests and those measuring emotional adjustment. Due to the lack of objectivity of these tests, the trained psychologist must be very careful with the interpretations he makes of the performances on these tests. It is very important to remember that there is nothing absolute or final about these results. The facts learned are significant and errors have been reduced to the point where the results are now in most cases considerably greater than chance. Feigning on a test is usually easily recognizable. The ability to hide one's real self is not possessed by most people. The skillful psychologist can also tell whether a person is functioning up to the level of his true general ability. However, the tests do represent the person's functioning at a particular

(*Continued on page 40*)

HERBERT J. RASS

ENGINEER—in charge of OPPORTUNITIES

by HERBERT J. RASS, *Manager, Employment Department*
ALLIS-CHALMERS MANUFACTURING COMPANY (*Graduate Training Course 1942*)

MAYBE that's a far-fetched way of putting it—but I am an engineer (Marquette 1941, Electrical Engineering) and a great many men do pass through the Employment Department to opportunities with Allis-Chalmers. I did the same thing myself.

During my last two years at Marquette in Milwaukee I worked as a cooperative student at Allis-Chalmers on the electrical test floor, in electrical product departments on both design and application work, and in the shops. When I graduated, I continued in the Graduate Training Course, on training location with what is now the Employe Relations Department. After six months—opportunity came around to look me up. The Company officer in charge of Industrial Relations talked to me about personnel work and asked if I'd like to go on with it as a career.

Liked Working With People

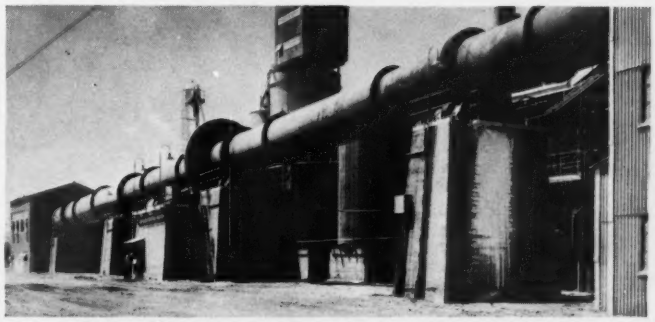
By that time I'd seen a lot of the Company, both product design and manufacturing, and I knew I liked working with people better than with machines, so it was just the break I wanted. During the war I was in the shops on personnel work, got a thorough grounding on operations carried on throughout the plant, and made many contacts. In 1950 I was made manager of the Employment Office.

Recruiting engineers for the Graduate Training Course is one of our functions, and perhaps this is a good place to tell something about the course.

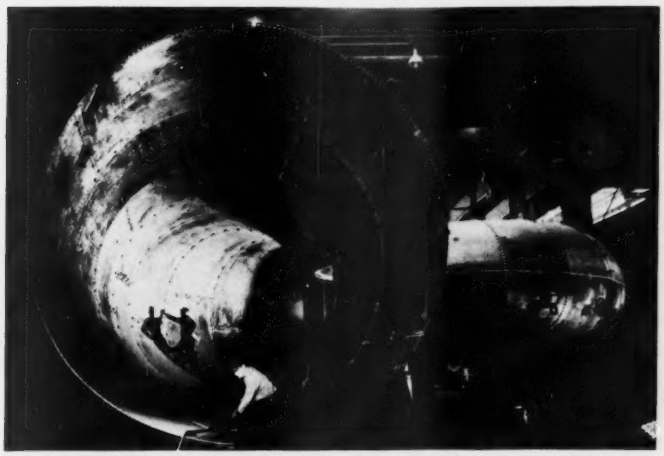
The course here is actually tailor-made for each man, and you help plan it. You can work it out to get concentrated training and experience in almost any phase of work that you want . . . even go on and get advanced degrees. Or, like so many of us, you may use it as an opportunity to get experience with many phases of the Company's operations.

Industry's Broadest Range

There are over 75 training locations for Graduate Training Course engineers at Allis-Chalmers' Milwaukee Plant alone. They include research, design and sales application on a wide range of products such as motors and generators, crushing, cement and mining machinery, steam and hydraulic turbines, centrifugal pumps, transformers, electronic equipment and milling machinery.



This is a 7 ft. x 8 ft. x 250 ft. rotary lime sludge kiln. Allis-Chalmers is also an important supplier of kilns to the cement industry.



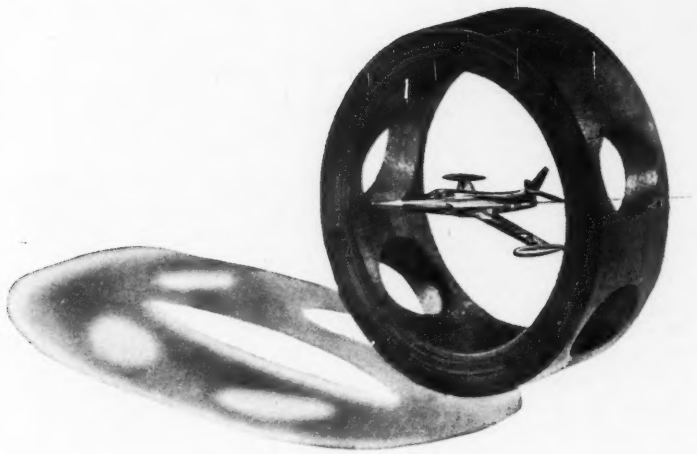
Giant spiral casing for hydro power project is one way of showing that Allis-Chalmers can build them big.

That's only part of it. You can go into the shops and manufacturing end of the business—work in planning and production control, personnel, time study, wage determination and labor relations. Or, there's laboratory and research, purchasing, advertising, sales training, export sales. Somewhere during the two-year course you're going to get a start in the work that suits you best. If you have the stuff, opportunity is going to come your way.

If you'd like more information about the Graduate Training Course, stop in for a visit at your nearest Allis-Chalmers district or regional office—or write for literature.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin



How to control a fast ball

When a jet airplane nears flying speed, its turbine rotor is spinning about 12,000 to 15,000 rpm. At that speed everything in the engine takes a beating.

Thrust and centrifugal forces are at work. Heat causes expansion stresses. Any imbalance sets up vibration. Then there is friction.

A jet engine is no spot for a part that can't take it.

One of the components that lead a hard life is the ball bearing for the main rotor shaft. It must be light in weight and compact. It must compensate quickly for distortion resulting from rapid and wide temperature changes. Shaft rigidity must be maintained and the bearing must overcome heavy gyroscopic forces and powerful thrust loads to do so. The shaft must be perfectly balanced to eliminate vibration at high rotary speeds.

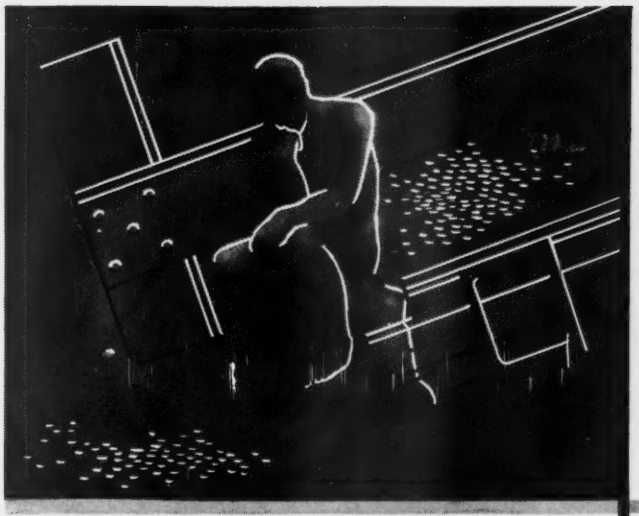
An important part of the bearing is the ball retainer. A large bearing manufacturer selected Synthane laminated plastic for his retainer.

Synthane is tough and highly resistant to wear and abrasion. Synthane is light in weight. Synthane is dimensionally stable over the temperature ranges encountered. Oils or greases have little or no effect upon it.

These are a few Synthane characteristics. It has many others—physical, mechanical, chemical and electrical. This Synthane *combination* of properties and characteristics may be the answer to one of your problems. To find out, send for the latest Synthane folder.
Synthane Corporation, 10 River Rd., Oaks, Pennsylvania.

PLASTICS WHERE PLASTICS BELONG

SYNTHANE



Thinking of improving

"Improving" any machine really means increasing its productive capacity. That means tinkering with speeds and weights and strength—ending up with alloy steels.

Which alloy steel?—the one that meets physical requirements at the lowest cost. Molybdenum steels fill that bill. Good hardenability, plus freedom from temper brittleness, plus reasonable price enable them to do it.

Send for our comprehensive 400-page book, free; "MOLYBDENUM: STEELS, IRONS, ALLOYS."

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS

Climax Molybdenum Company
500 Fifth Avenue · New York City

MOLY

C2

What is
PRODUCT UNIFORMITY
in a bearing
Take any lot of SKF Bearings of a specific size and type, and you won't find one differing from the other. This uniformity of product is *your* assurance of getting the right bearing in the right place *every* time. SKF Industries, Inc., Phila. 32, Pa. 7179
SKF
Ball and Roller Bearings

psychological diagnostic service

(*Continued from page 36*)

time, on a particular test, and under particular circumstances. There is nothing in any of the existing psychological tests that give information that a series of interviews over an extended period of time would not give just as well. The reason for using the psychological tests is to get some index in these five general areas in which the individual lives and operates in as short a time as possible in order to expedite the whole process of counselling. Given certain basic general ability and good reading skill, many of the problems of the average MIT undergraduate are those of emotional adjustment.

One further word about the value of these tests to the students themselves. After the tests have been taken, the psychologist, Dean, or psychiatrist makes interpretations to the student. However, in some cases these interpretations are not entirely necessary since the student by the mere process of taking the test has learned a great deal about himself and his interest. There is a certain amount of self-education derived from the mere taking of these tests. If further interpretation is given him by a professional person, the inaccuracies of the test can be somewhat diminished and a great deal of benefit derived from them.

This service, when combined with the efforts of other specialists and administrative personnel, should aid the student in solving many of the problems that vitally affect his present as well as future well-being.

the cost of an education

(*Continued from page 18*)

Question	*Frosh*	*Sophs*	*Juniors*	*Seniors*
		Hours/week		
(1)	27	26	30	28
(2)	4.55	4.75	4.75	4.15
		not		
(3)	50	determined	51.5	51.5
(4)	5.6	6.9	8.2	8.7

Every case varies, but below is presented a picture of the average Tech Freshman.

His name is Tim Tech. He smokes a bit and drinks occasionally — he hasn't been here long. Besides his tuition, he receives $125 each month which takes care of him quite nicely.

Tim has from five to six hours of classes each day and studies about the same amount of time in the evening. Once in a while he spends a few hours playing baseball, but most of his extra time in the afternoon is taken up by his two activities. On weekends he takes in a movie or, once in a while, has a date with a girl he met at the last acquaintance dance. He plans to take up swimming next spring, and maybe try out for the freshman tennis team at the same time. As for his course, right now Tim has signed up for Electrical Engineering, but he will probably change to Course Fifteen next year.

Anyway, let's face it — Tech is Hell!

a magic tesseract

(*Continued from page 9*)

one of the possible arrangements of the above, expanded and expressed in the decimal system.

0	40	$\overline{80}$	49	62	9	71	18	31
(67	(26	($\overline{27}$)	8	36	76)	45	58	17)
53	54	13	63	22	35	4	44	72
41	78	1	60	10	50	19	32	69
24	28	$\overline{68}$	37	77	6	59	15	46
55	14	$\overline{51}$	23	33	64	42	73	5
79	2	39	11	48	61	30	70	20
29	66	25	75	7	38	16	47	57
12	52	56	34	65	21	74	3	43

In each of the four perpendicular directions, the sum of the three numbers in line is 120. In this particular layout, each subsquare in the 3 by 3 array of 3 by 3 squares is a degenerate sort of magic square which is not made up of consecutive numbers. This gives lines in two directions. For 27, there is $67 + 26 + \overline{27} = 120$ and $80 + \overline{27} + 13 = 120$. Lines in the other directions run from corresponding positions in the subsquares in the same row or column. For 27, they are $\overline{27} + 76 + 17 = 120$ and $\overline{27} + 68 + 25 = 120$.

The production of a 3 by 3 by 3 by 3 by 3 magic figure awaits only someone with lots of time and undirected ambition to apply the above technique to produce it.

Similar techniques may be used for prime n, greater than three. For n sufficiently large, diagonals may also be made to add up to the key number. I am sure that all who have stayed with me to the end will be eager to drop all other work and start constructing magic figures. Good luck in your new lifetime occupation!

Faster Fighting Finishes

CHEMICAL PROBLEM..

. . . protective coatings for defense and other hardworking uses which dry extremely fast, speed production, and last long in service.

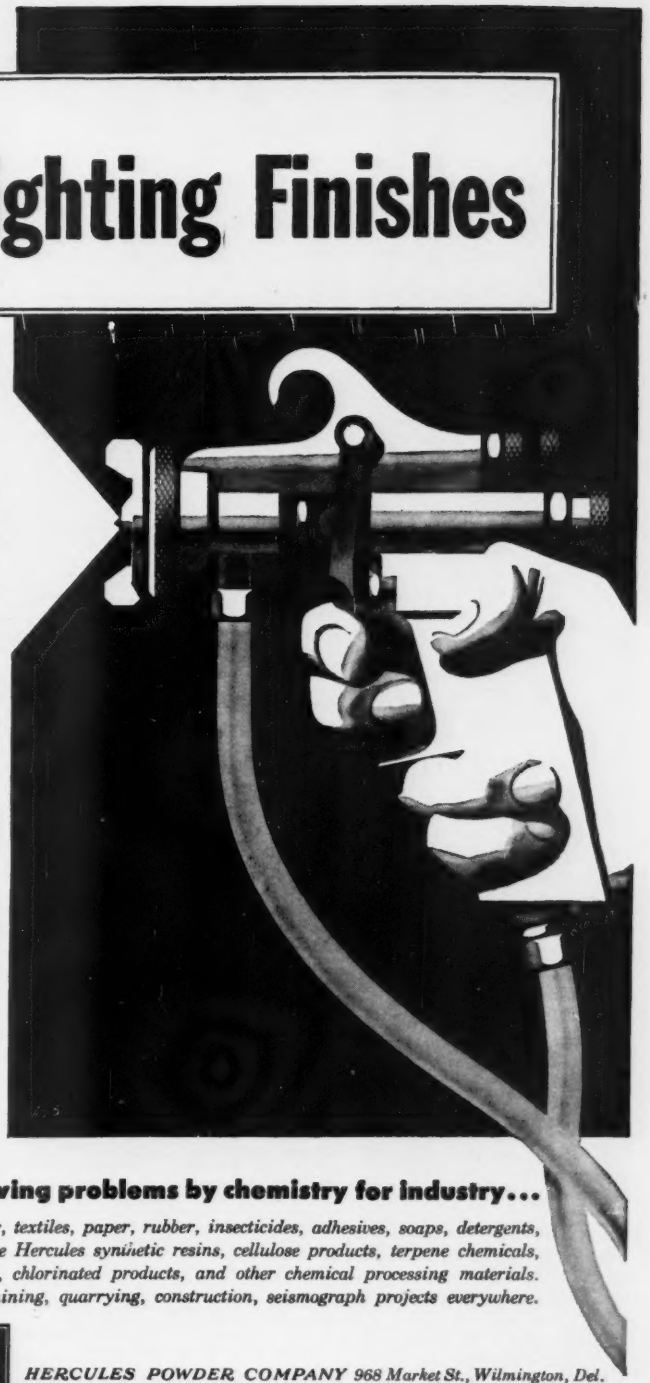
SOLUTION...

. . . special lacquers made by Hercules customers with nitrocellulose and other ingredients developed through Hercules research. Widely accepted over the years for automobiles, furniture, and other metal and wood products for its fast dry, economy, and beauty, lacquer today is a better finish than ever.

Now—with the development of a hot-spray process—lacquer made with special Hercules resins and nitrocellulose can be sprayed on in almost double the thickness.

COLLEGE MEN...

This is but one example of the far-reaching chemical developments in which you could participate at Hercules—in research, production, sales, or staff operations. It suggests the ways Hercules' products serve an ever-broadening range of industries and end-uses. For further information, write for 28-page book, "Careers With Hercules".



Hercules' business is solving problems by chemistry for industry...

. . . paint, varnish, lacquer, textiles, paper, rubber, insecticides, adhesives, soaps, detergents, plastics, to name a few, use Hercules synthetic resins, cellulose products, terpene chemicals, rosin and rosin derivatives, chlorinated products, and other chemical processing materials. Hercules explosives serve mining, quarrying, construction, seismograph projects everywhere.

HERCULES

HERCULES POWDER COMPANY 968 Market St., Wilmington, Del.
Sales Offices in Principal Cities

"Open up... *it's the police!"*

"What a way for a guy to wake up!

"Maybe we shouldn't've listened to that horror program on the radio, where secret police dragged a family off to a concentration camp.

"Anyway, when that pounding on the door woke up Ethel and me... brother, I was practically on my way to some Siberian salt mine.

"Sure, I finally opened the door... and there stood McCarthy, the night cop on our beat. It was only a short-circuit fire in our kitchen.

"*Only* a fire? Wow! But with his help we put it out before any damage was done. Then Ethel made hot coffee and we finally got back to bed.

"Only I couldn't get back to sleep for a couple of hours. Kept thinking suppose it *was* the secret police! But that was nonsense. Here in America the police *help* us . . . not *hound* us like they do in countries where folks have forgotten what the word 'Freedom' means.

"Ah-h-h . . . Freedom! Pick your own church, your own newspaper, your own candidates. Pay your taxes but do what you want with the rest. Own a house or rent it. Drive your own car or take a bus. Loaf or pick out a good job like I have with Republic. Help produce steel or autos or tanks . . . or work in a store or a bank, as you please.

"Guess I'd gotten maybe a little too used to these Freedoms to appreciate them. So I made myself some promises. One was to read further than the sports pages. Another was to keep my eyes and ears peeled for those characters who try to do us out of our Freedoms.

"I've been a thinking man since McCarthy almost broke our door down . . . bless him!"

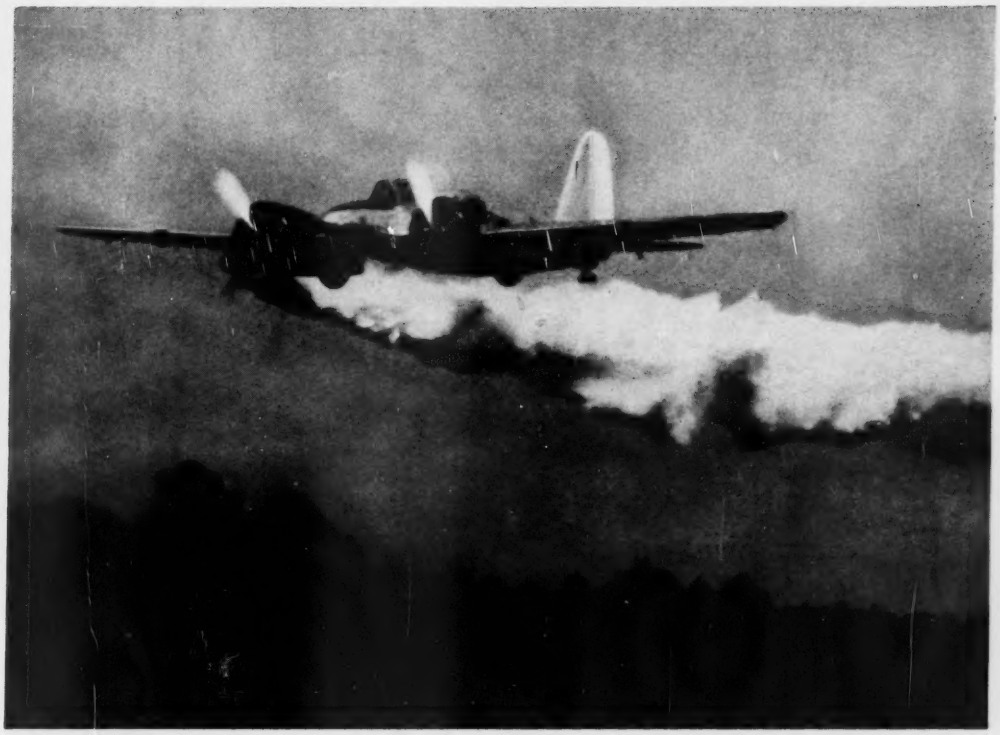
REPUBLIC STEEL

Republic Building, Cleveland 1, Ohio

Republic BECAME strong in a strong and free America. Republic can REMAIN strong only in an America that remains strong and free... an America whose giant industries have made her a giant among the nations of the world. *And through these vast industries, Republic serves America.* Take, for instance, our great Construction Industry . . . builders of homes and homesteads, stores and office buildings, mills and factories. Structures of sturdy steel, built with equipment of steel . . . the kind of quality steel Republic produces in increasing yearly tonnages to help keep America the buildingest nation in all history.

* * *

For a full color reprint of this advertisement, write Dept. H, Republic Steel, Cleveland 1, Ohio



How to open a can of fog

The pilot pushes a button on the instrument panel.

And instantly, from metal tanks fixed to a warplane's fuselage, thick streams of artificial fog pour forth.

Today it is possible for a fast plane to obscure an Army division or a Navy squadron in a matter of seconds. For scientists and engineers at Corning Glass Works, working with the Armed Forces, have developed a new way to open a can of fog.

A specially engineered disc of one of the tough Corning glasses is used to form the end of the metal fog chamber. In the center of this glass disc, which is sealed to the metal can, is a percussion cap—connected electrically with the plane's instrument panel.

When the pilot pushes the button, the percussion cap is detonated, breaking the glass disc and opening the end of the cylinder.

Since the containers have to be stored at depots scattered from the tropics to the polar regions, the discs are made of heat- and cold-resistant glass which sudden temperature changes won't break. The glass has to be strong to prevent releasing the fog-making ingredients prematurely.

And the discs are made so that they will break evenly and completely from the force of the exploding percussion cap.

The design for this strong, heat-resistant glass disc that will break in a predetermined way is only one of the more than 37,000 designs for glass products developed by Corning engineers in a full century of glass-making.

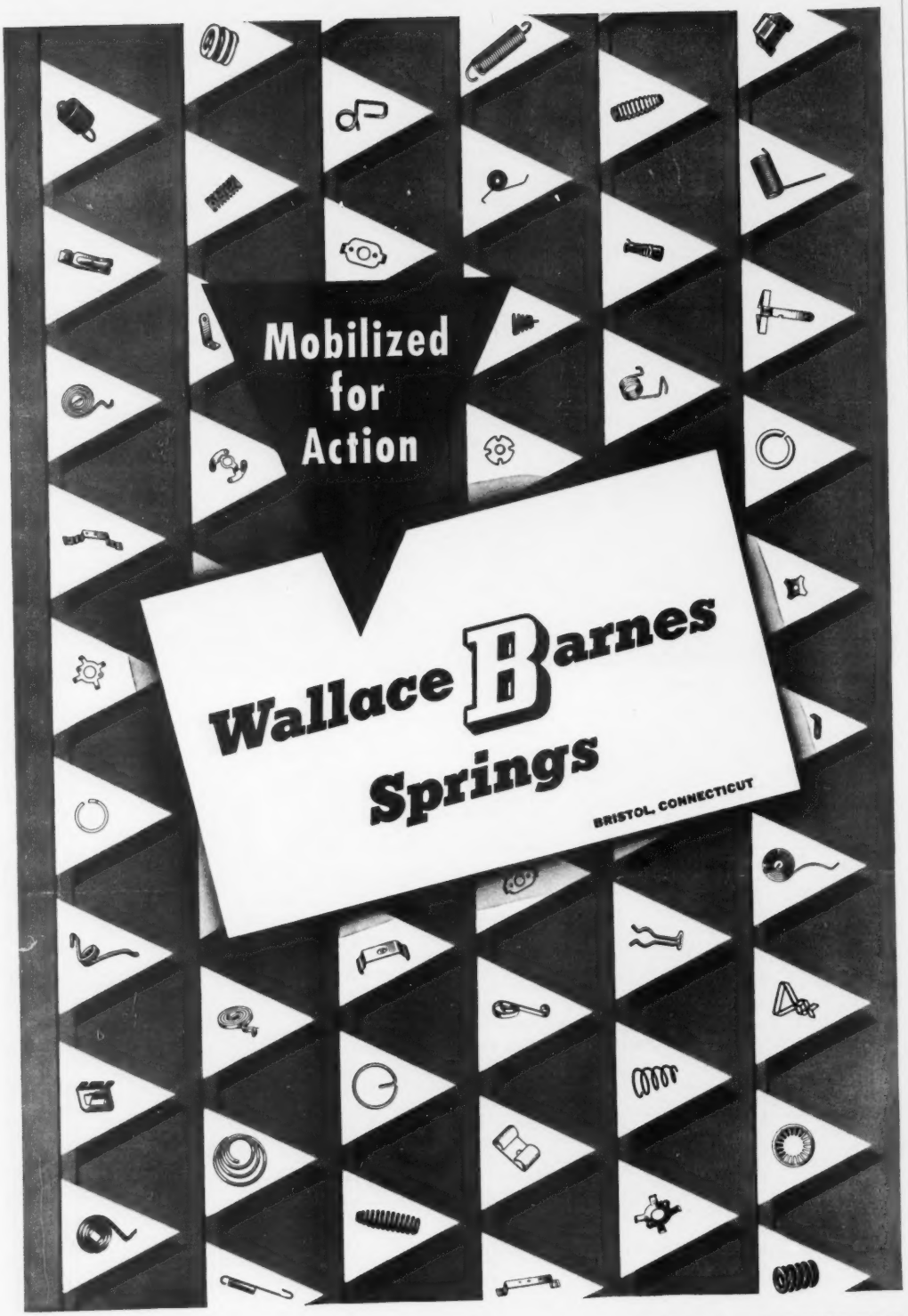
Today, throughout industry — *Corning means research in glass*, research concerned with making glass do countless jobs never thought possible before.

Glass, as made by Corning, is a material of limitless uses. That's a good thing to remember when you're out of college and concerned with new products and processes or improvements in old ones.

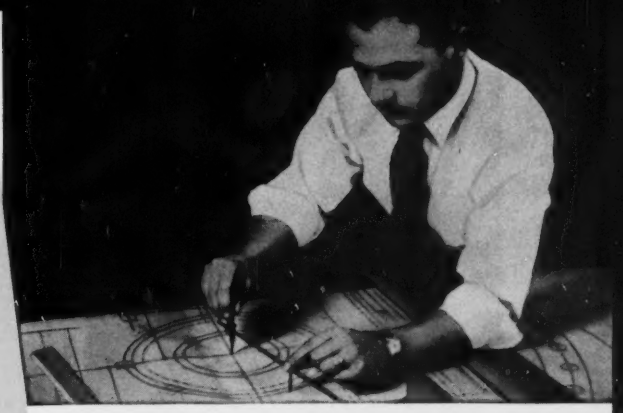
Then, if you think glass can help, we hope you'll write us before your planning reaches the blueprint stage. *Corning Glass Works, Corning, New York.*

CORNING
means research in glass

1851—100 YEARS OF MAKING GLASS BETTER AND MORE USEFUL—1951


Mobilized
for
Action
Wallace Barnes
Springs
BRISTOL, CONNECTICUT

Extreme accuracy makes photography a matchless engineering tool

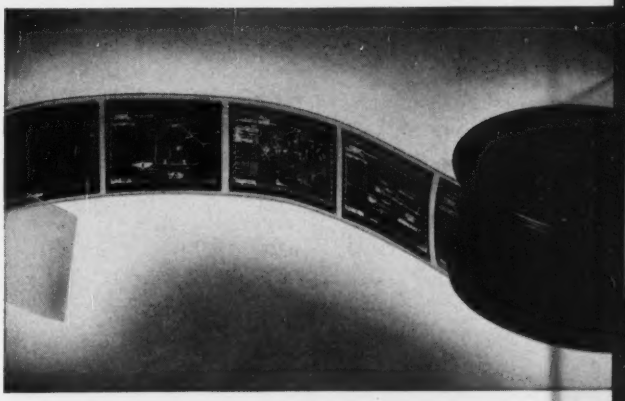


DRAWINGS ARE COPIED FAITHFULLY. Photocopying reproduces engineering drawings, data, specifications, with high speed, utmost accuracy and in any quantity. Bright copies can be made from dimmed material. Originals are saved from wear and tear.

Accuracy is but one of the unusual abilities of photography which are important in engineering and other professions and businesses alike. Through its speed it can provide movies that slow down action which would be far too fast for eyes to follow. Through radiography it checks castings, welds, and assemblies without destroying the part.

And so it goes all through the profession. You find photography saving time, improving products and procedures, simplifying processes.

Eastman Kodak Company, Rochester 4, N. Y.

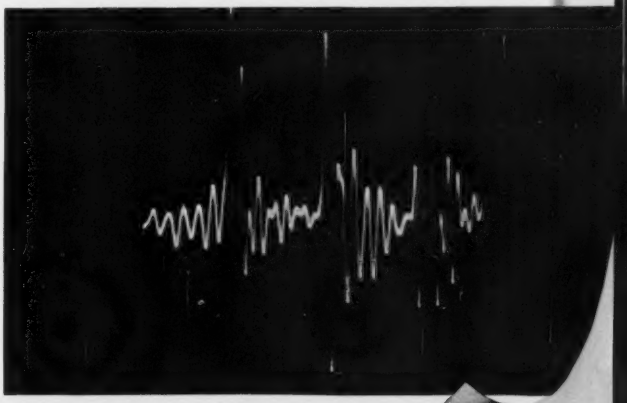


IMPORTANT RECORDS PRESERVED. With microfilming, engineering drawings and valuable records can be preserved with every detail intact. The film can be stored for easy reference in 98% less filing space than the originals would require.

College graduates in the physical sciences, engineering, and business administration regularly find employment with Kodak. Interested students should consult their placement office or write direct to Business and Technical Personnel Department, Eastman Kodak Company, 343 State Street, Rochester 4, N. Y.

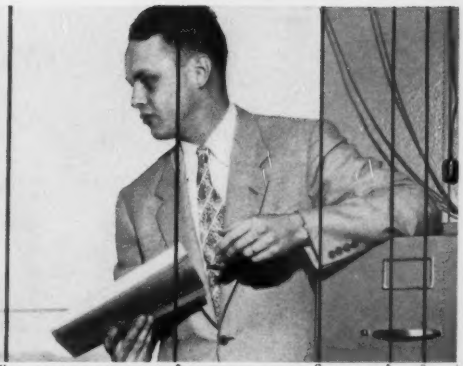
Send for this FREE Book

It tells how photography is used to:
Speed production • Cut engineering time
Assure quality maintenance • Train more workers faster • Bring new horizons to research



INSTRUMENT READINGS RECORDED. Fleeting traces of the galvanometer mirror or cathode-tube beam can be recorded for study and analysis. Movement too fast for the eye is caught accurately by photography.

Kodak
TRADE-MARK



Accounting, Auditing, 55% | Marketing, 17% | Admin., 15% | Other Jobs, 7% | Advt., 3% | Mfg., 3%

Research—Development, Design, Production, Application Engineering, 60% | Marketing, Sales, 20% | Other Jobs, 20%

What happens to all the college graduates General Electric hires?

About 55 per cent of the graduates of General Electric's Business Training Course are now making their careers in accounting and auditing work. About 17 per cent are in marketing; 15 per cent in administrative and management; 3 per cent in advertising; 3 per cent in manufacturing; with 7 per cent in fields ranging from purchasing to employee relations.

Of the more than ten thousand engineers and other specialists at General Electric, about 60 per cent are in some phase of engineering or research, with 20 per cent in marketing, and the other 20 per cent in manufacturing, purchasing, etc.

Figures like these help to prove that there are no fixed paths for college graduates at General Electric. The graduate who enters a G-E training program doesn't commit himself irrevocably to one type of work.

It's a G-E tradition to encourage the newcomer to look around, try several different assignments on for size, find the kind of job which he believes will be most satisfying and to which he can make the greatest contribution.

You can put your confidence in—

GENERAL ELECTRIC